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**COVER NOTE**

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**COMMISSION STAFF WORKING DOCUMENT**

**IMPACT ASSESSMENT**

*Accompanying the document*

**Proposal for a COUNCIL REGULATION**

**on the Fuel Cells and Hydrogen 2 Joint Undertaking**

{COM(2013) 506 final}
{SWD(2013) 261 final}

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*Accompanying the document*

**Proposal for a COUNCIL REGULATION**

**on the Fuel Cells and Hydrogen 2 Joint Undertaking**

| | |
|---|---|
| AIP | Annual Implementation Plan |
| CfP | Call for Proposals |
| CHP | Combined Heat and Power |
| CIP | Competitiveness and Innovation framework Programme |
| N.ERGHY | Research Grouping (of the FCH JU) |
| EC | European Commission |
| ETP | European Technology Platform |
| EU | European Union |
| FCEV | Fuel Cell Electric Vehicle |
| FCH | Fuel Cells & Hydrogen |
| FP | (Research) Framework Programme |
| FP7 | $7^{th}$ (Research) Framework Programme |
| GB | Governing Board of the FCH JU |
| GHG | Greenhouse Gas |
| IEA | International Energy Agency |
| IPHE | International Partnership for Hydrogen in the Economy |
| JTI | Joint Technology Initiative |
| JU | Joint Undertaking |
| LPG | Liquefied Petroleum Gas |
| LVH | Lower heating value |
| mCHP | Micro Combined Heat and Power |
| MAIP | Multi-Annual Implementation Plan |
| MS | Member State |
| NEW-IG | New Energy World – Industry Grouping (of the FCH JU) |
| PEM | Polymer Electrolyte Membrane or Proton Exchange Membrane |
| PPP | Public-Private Partnership |
| R&D | Research & Development |
| RCS | Regulations, Codes and Standards |
| SET-Plan | (European) Strategic Energy Technology Plan |
| SME | Small and Medium Enterprise |
| USDOE | United States Department Of Energy |

**COMMISSION STAFF WORKING DOCUMENT**

**IMPACT ASSESSMENT**

*Accompanying the document*

**Proposal for a Council Regulation**

**on the Fuel Cells and Hydrogen 2 Joint Undertaking**

# 1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

## 1.1. Background for the development of the legislative proposal

1. Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme provides the basis for a Community contribution to the establishment of long term Public Private Partnerships (PPP) in the form of Joint Technology Initiatives (JTIs).

2. In 2008, Council Regulation (EC) 521/2008 established the Fuel Cells and Hydrogen (FCH) Joint Undertaking (FCH JU) for a period up to 31 December 2017, set-up as a PPP with 50/50 co-financing between the two founding members, the European Commission and the FCH Industry Grouping. Shortly after the establishment of the FCH JU, the Research Grouping became a member. The maximum EU contribution to the FCH JU is 470M€.

3. The Commission Communication 'Partnering in Research and Innovation'[1] indicates that the partnering approach in PPP can help to address major societal challenges and strengthen Europe's competitive position by making the R&I cycle more efficient and shortening the time from research to market. It can also contribute to environmental and resource efficiency objectives. When the necessary commitment to partnering exists, Europe can excel in science and technology and achieve critical mass.

4. The Commission's proposal for Horizon 2020[2] provides a legislative basis for future EU PPPs in Research and Innovation. It stipulates that Horizon 2020 may be implemented through PPPs where all the partners concerned commit to support the development and implementation of research and innovation activities of strategic importance to the Union's competitiveness and industrial leadership or to address specific societal challenges.

5. According to the proposal, the PPP shall be identified based on the following criteria:

   (a) the added value of action at Union level;

[1] COM(2011) 572 final of 21.09.2011
[2] COM(2011) 809 final of 30.11.2011

(b) the scale of impact on industrial competitiveness, sustainable growth and socio-economic issues;

(c) the long-term commitment from all partners based on a shared vision and clearly defined objectives;

(d) the scale of the resources involved and the ability to leverage additional investments in research and innovation;

(e) a clear definition of roles for each of the partners and agreed key performance indicators over the period chosen.

6. The Commission's proposal presents also a common set of rules for all initiatives supported under Horizon 2020 in order to simplify participation, while leaving the necessary flexibility for individual initiatives to achieve their objectives.

## 1.2. Organisation and timing

7. This Impact Assessment was elaborated by DG RTD. In this context, a Commission Inter-Service Group (ISG) has been created in June 2012. In addition to DGs ENER, MOVE and JRC, it included DGs ENTR, CNECT, COMP, MARKT, SANCO, HR, SG, BUDG and Legal Service. Meetings have been held for all major steps in the development of the initiative. In relation to this Impact Assessment, the ISG met during 2012 on June 8$^{th}$, July 20$^{th}$, September 20$^{th}$, November 22$^{nd}$ and December 12$^{th}$.

## 1.3. Consultation and expertise

8. In the preparation of this Impact Assessment, the Commission has consulted stakeholder groups representing the industry and research communities, the Member States and the general public. Several workshops and ad-hoc meetings were organised in the course of 2012 to discuss priorities for research on fuel cells and hydrogen, and define the best mechanism to implement the research & innovation programme at European level. The Impact Assessment has been carried out by DG RTD, with support from mainly ENER, MOVE, JRC and the JU Programme Office. In June 2012, external experts have been engaged to support the Commission services in the finalisation of the report (see Annex 1). The different sources of information as well as the consultation process are briefly described below.

9. Several key reports have been used in the preparation of the present Impact Assessment. In addition to EU and USDOE reports[3] on energy, transport and climate change, the most important ones are:

- First Interim Evaluation of the Fuel Cell & Hydrogen Joint Undertaking (2011)
- IEA 2012 Energy Technology Perspective
- Technology Map of the SET-Plan (JRC, 2011)

[3] http://www.hydrogen.energy.gov/library.html

- FCH JU Industry Grouping Financial and Technology Outlook 2014-2020
- Fuel Cell Today "Industry Review" 2010, 2011 and 2012, as well as the "Patent Review"
- The McKinsey reports "Pathways to a Low Carbon Economy" (2009) and "A portfolio of power-trains for Europe: a fact-based analysis" (2010)
- Pike Research, "Fuel Cells Annual Report 2012" and "Ten Trends to Watch in 2012 and Beyond"

10. As part of the Impact Assessment, a cost-benefit analysis[4] concerning the JU as choice of administrative structure for the JTI instrument has been carried out by the Commission Services.

11. The Impact Assessment Board (IAB) examined the draft during their meeting on 27th February 2013, and proposed a number of improvements in its opinion dated March 1st 2013. Following this opinion, the present IA report was revised as follows: i) The Problem Definition (chapter 2) has been revised, giving more prominence to the results of the 1st Interim Evaluation and to the actual performance of the FCH JU relative to the targets set in 2008. The implication for the JU of the increasing role of hydrogen as a medium for storing renewable electricity has been described in more detail. ii) The relevance, feasibility and targets of the specific objectives have been better justified. iii) The concretely available policy options within the Horizon 2020 framework have been explained in terms of scope, governance structure and modus operandi. iv) The preferred policy option has been underpinned by concrete evidence from the conclusions of the interim evaluation, as well as by the results from the stakeholder survey and the public consultation. Full summaries of all three documents are included as annexes.

### 1.4. Main stakeholder views

12. In November 2011, the **Industry Grouping** (NEW-IG, a founding member of the JU) issued its Financial and Technology Outlook for the European fuel cell and hydrogen sector for 2014-2020. This document, that identifies the technological priorities and financing needs for the sector until 2020, underscores that support to deployment would become increasingly important and that new support mechanisms would have to be developed. The Industry Grouping calls for a prolongation of the FCH JU, though with a broader scope, including extended support to early deployment activities.

13. The **Research Grouping** (N.ERGHY, a member of the JU), through its answer to the public consultation as well as through its official Position Statement, is very positive on the achievements of the current JU, and believes that neither the industry alone nor the fragmented support at national level only will allow the European FCH sector to be competitive on the worldwide scene. N.ERGY therefore strongly supports an intervention at European level, preferably through a modernised JU. It also calls for a revision of the technology objectives, the budget and the rules for participation and dissemination.

[4] http://intranet-rtd.rtd.cec.eu.int/int_com/docs/CBA_JU.pdf

14. The two advisory bodies of the current Joint Undertaking, the Scientific Committee and the Member States Representatives Group, have issued their opinions supporting the continuation of the Joint Undertaking and provided recommendations on its objectives, scope and operations, and on their own mandates.

15. The Scientific Committee of the FCH JU, in its "Views of the Scientific Committee on the next phase of the FCH JU" commented in particular on the type of activities to be implemented within the JU (basic and applied research, technology development, demonstration, early deployment), and insisted on increasing the interaction with other EU programmes under Horizon 2020 relevant to energy and transport, such as "Advanced Materials" and "Advanced Manufacturing and Processing".

16. The Member States Representative Group agrees on the importance of the JU, and confirms that the JU model has proved to be an efficient way to coordinate funding from different Commission DGs to develop a new energy technology. Overall, Member States support the continuation of the JU, and are ready to contribute to its follow-up in Horizon 2020.

17. A study was commissioned by the FCH JU on trends in terms of investments, jobs and turnover in the fuel cells and hydrogen sector. As part of this study, a **stakeholder survey** was sent to all the beneficiaries of the FCH JU (more than 400 entities), including a detailed questionnaire to the 60 members of NEW-IG. The survey enquired about their perception of the current market situation for fuel cells, their forecast for commercialisation of products, their expenditures on R&D and market introduction activities, and the personnel they employ. Feedback was requested on the impact of the EU research programmes and of the Joint Undertaking on the beneficiaries' activities to date, and on the policy options for the implementation of fuel cells and hydrogen R&D in Horizon 2020. In total 154 responses were received, including 46 from the IG. The survey shows that 70% of the members of the Industry Grouping have seen their turnover on FCH increase since 2007 and 70% have raised their expenditures on R&D (half of those members by even more than 20%). About half of the responding members report additional expenditures on R&D as a result of the establishment of the JU. Regarding the stakeholders group as a whole (i.e. not restricted to the Industry Grouping), 77% have increased their R&D expenditures, and 67% have done so as a result of the establishment of the JU. A summary of the results from the stakeholder survey is presented in Annex 2.

18. FCH industry players also indicate that the JU has provided stability and long-term commitment, delivering support that neither national nor private programs can give, including to nascent technologies. It has established a central focal point from which coalitions can be built, allowing companies in other regions to find and connect to JU members. Furthermore, it provides "one strong voice to policy makers and stakeholders abroad". The survey shows that 93% of the beneficiaries are in favour of continuation of the JU.

19. Looking towards 2014-2020, the industry players (half of them NEW-IG members) expect their turnover to multiply by 8 and their expenditures on R&D and deployment activities to more than double. Concerning R&D and deployment, it was clear from the survey that the continuation of the JU (especially in its modernised

version) is the favoured option to trigger additional investment. In a modernised JU, 54% of the NEW-IG members would invest more. In the case of continuation of the current JU, collaborative research or a Contractual PPP, these figures would be 37%, 30% and 28% respectively. In the majority view of the responding NEW-IG members, the modernised JU is the most successful vehicle to enhance the efficient use of research resources (72% of respondents), strengthen the coordination of research between the JU and MS (61%), increase the impact on product development (74%) and trigger the creation of jobs in the FCH sector (59%).

20. In parallel to the stakeholders' consultation, a **public consultation** was conducted between July and October 2012. 127 responses were received. Most respondents agree on the fact that FCH technology will play a notable role in the future EU low-carbon energy and transport sectors (98% of respondents), for the EU energy security of supply (94%) and for the EU industrial competitiveness (95%). Most also agree that the currently targeted applications can have an important socio-economic impact by 2020, with a particularly strong support for the use of hydrogen as storage medium for renewable energy (95% of respondents). Most respondents also believe that both the European FCH industry and the FCH research sector are more competitive or stronger than 5 years ago, and that they have the potential to be even more competitive by 2020 (99% for industry, 95% for research). The support to FCH R&D in the EU is overwhelming (96% of respondents). The continuation of the JU - in its current form or modernised - is the favoured option (70% calling for a continuation, incl. 53% in a modernised version), while a Contractual Public-Private Partnership is only favoured by 4%. Most respondents believe that the aim and scope of the initiative should go beyond R&D and include support to early deployment activities and that the budget should increase. A summary of the results from the public consultation is presented in Annex 3.

21. Differences and overlap between the stakeholder survey and the public consultation, as well as minority views, are presented in Annex 4.

## 2. PROBLEM DEFINITION

### 2.1. General Context

22. Hydrogen, as an energy carrier, and fuel cells as energy converters, are technologies that offer a pathway for clean systems that reduce emissions, enhance energy security, and stimulate the global economy. Their potential applications include a number of strategic sectors, such as power generation and surface transport, and, on the long term, are expected to contribute to the EU energy and climate objectives. Annex 5 provides a discussion on the likely impacts of the technologies in certain areas that are relevant to the societal challenges that Horizon 2020 addresses.

23. At EU level, the European Commission has supported research and development in fuel cells and hydrogen technologies since the early EU Framework Programmes (FP) with increasing funding levels over time (e.g. 145 M€ in FP5, 315 M€ in FP6).

24. In the absence of a clear European strategy, these efforts were fragmented and uncoordinated across the different FP sub-programmes, i.e. Energy (the main one), Transport, Materials and Environment, and stakeholders, notably the European

industry. It was not until the launch of the FCH JU[5] in 2008 that the European private and public sectors joined together to co-ordinate their efforts under a genuine European strategy, with a common set of goals.

25. In 2009 the European Union adopted a set of legislation (known as "*Climate and Energy Package*"), which sets a series of key energy objectives for 2020 with binding commitments from the Member States: to reduce greenhouse gas emissions by 20%, rising to 30% if the conditions are right; to increase the share of renewable energy to 20%; and to make a 20% improvement in energy efficiency. This policy is a key contribution for achieving the objective of the Europe 2020 strategy for smart, sustainable and inclusive growth.

26. The direction to be followed after the 2020 agenda is presented in the Energy Roadmap 2050 adopted by the Commission on 15th December 2011[6]. This Roadmap explores the routes towards a secure, competitive and decarbonised energy system by 2050. The Roadmap highlights the important role to be played by switching to renewable energy sources, managing electricity in new ways and shifting towards alternative fuels, including hydrogen.

27. On January 23rd 2013 the Commission adopted a Communication "*Clean Power for Transport: A European alternative fuels strategy*" which was accompanied by a legislative proposal setting binding targets for the build-up of the minimum alternative fuels infrastructure, with special emphasis on common standards. Hydrogen is one of the alternative fuels included in the Package.

28. The Commission proposal on Horizon 2020 envisages activities supporting FCH technologies under the Societal Challenge "Secure, clean and efficient energy" and “Smart, green and integrated transport”.

## 2.2. FCH can contribute to growth, jobs and competitiveness

### *2.2.1. Europe's competitiveness needs to be strengthened*

29. Overall, the FCH market has shown a considerable growth. The global turnover for fuel cells and hydrogen is expected to be US$785 million in 2012[7], which is 2.5 times the figure of US$300 million in 2005[8]. Global fuel cell shipments are anticipated to grow at a compound annual growth rate of around 20% during 2012-2015[9]. The global market is expected to be worth $15.7 billion in 2017[10], and a recent US study estimates that it could be between US$ 43 billion and US$ 139

5 Council Regulation (EC) No 521/2008 of 30 May 2008

6 Energy Roadmap 2050, COM/2011/0885, 15.12.2011

7 Pike Research, Ten Trends to Watch in 2012 and Beyond, http://www.pikeresearch.com/research/smart-energy/fuel-cells

8 2007 FCH JTI Impact Assessment

9 “Fuel Cell Market Forecast to 2015”. Research Report. RNCOS. July 2012; see: http://www.marketresearch.com/RNCOS-v3175/Fuel-Cell-Forecast-7063439/

10 Pike Research, Fuel Cells Annual Report 2012

billion annually over the next 10 to 20 years[11][12]. The market share of Europe fluctuates around 12%.

30. In terms of power installed, 80 megawatts were shipped in 2011, of which **stationary power** accounted for 62 MW and transport for 18 MW. Europe (with 11 MW shipped in 2010) is far behind North America (45 MW) and Asia (22 MW), in particular for stationary power applications where Japan has commercialised 20,000 units of residential CHP since in 2009[13] using public subsidies. Europe's position is better in the **transport** sector thanks to major development and demonstration initiatives[14] that have become international references. However, Europe's global presence is insufficient to maintain its leading position as a producer of vehicles. **Early markets** are dominated by small portable devices and forklifts. Portable fuel cells account for 95% of the total units produced[15], boosted by sales of fuel cell auxiliary power units (APUs) in the leisure sector where they offer a longer-running power solution than batteries. In forklift applications, the US has a world leader position having deployed more than 1,000 fuel cell-based forklifts (versus only a few ones in the EU). However, Europe holds a strong global position with half of the world's total production of conventional forklifts that offers clear opportunities for the FCH sector.

#### *2.2.2. New jobs must be created in the European FCH sector*

31. It is estimated that the European fuel cell and hydrogen industry currently supports over 9,000 jobs (more than 3,000 directly and over 6,000 indirectly). Worldwide, these figures are 39,000 jobs in total (13,000 direct and 26,000 indirect)[16] . The stakeholder survey reports a 30% increase of direct jobs since 2007 in Europe. Forecasts regarding the development of employment in the FCH sector depend on different scenarios and always have to be viewed in a global context.

32. In a socio-economic analysis under the FP6 Integrated Project HyWays[17], impacts of the deployment of FCH technologies on employment were analysed according to different export/import scenarios with a focus on 6 European countries (France, Germany, Greece, Italy, Norway, and The Netherlands). According to the "*Optimistic*" scenario, when great efforts are undertaken to increase EU exports in hydrogen vehicle and technologies, employment effects e.g. for Germany, France and Italy could be substantial (in the order of 300,000, 125,000, and 40,000 over the next 20 years respectively). On the other hand, the "*Pessimistic*" scenario, which assumes that other world regions take over the leading position and Europe has to import hydrogen vehicles, results in dramatic losses of jobs.

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11 US DoE Hydrogen and Fuel Cells Program Plan, September 2011

12 Joint Research Centre: 2011 Technology Map of the European Strategic Energy Technology Plan (SET-Plan). European Commission. Joint Research Centre. Institute for Energy and Transport. 2011. p. 125

13 http://www.fuelcelltoday.com/analysis/analyst-views/2012/12-02-29-ene-farm-update

14 See for example the Clean Energy Partnership (CEP), the H2 Mobility initiative in Germany, the Scandinavian Hydrogen Highway Partnership (SHHP) and the Clean Hydrogen in European Cities (CHIC) project (http://chic-project.eu/)

15 Fuel Cell Today Industry Report 2011

16 A Compendium of Job Estimates in the Fuel Cell Industry, Fuel Cell 2000, http://www.fuelcells.org/Fuel_Cell_Industry_Job_Estimates.pdf

17 Wietschel, M. et al.: HyWays Socio-economic analysis. Final Report. 18.12.2005

33. In terms of new job creation, the most pessimistic studies conclude that the overall impact on employment is likely to be modest. More optimistic reports, such as several US DoE studies[18][19], Fuel Cell Today[20] or Fuel Cell 2000, point to the creation of up to several hundreds of thousands of jobs in the US by 2020 or 2030. The overwhelming majority of new jobs will be in stationary fuel cells. Manufacturing jobs are expected to be largely found in Asia. For example, South Korea has announced a strategic plan to become a global leader in fuel cell manufacturing, aiming at creating 560,000 jobs[21]. Installation and maintenance jobs will be created mostly in Europe and North America. As for the regional distribution, 51% of new jobs worldwide are estimated to appear in Asia, 23% in North America, 21% in Europe, and 5% in the rest of the world.

Although the FCH sector is small, it is of strategic importance due to its potential knock-on effect for example on the European automotive industry, which employs several millions of people. It is estimated that by 2040-2050, 10-15% of all cars manufactured in the EU will be FC-based. If Europe fails to become a competitive provider of FCH technologies, this would result in a significant loss of jobs in the European automotive industry.

### 2.3. Public funding is supporting the innovation chain from idea to the market

34. Public R&D support for FCH technologies was estimated by the IPHE[22] in 2010 at slightly over 1 billion US$ worldwide annually. Europe (EU + Member States) accounted for around 32% of this amount, the US 38%, Japan 20%, South Korea 6% and China 3%.

35. In the US, the Congress earmarked approximately US$150 million in FY2011 for the DoE Hydrogen and Fuel Cells Program, in addition to individual States' research programmes whereas Japan invested US$240 million in 2012 and has decided to build 100 new hydrogen refuelling stations over the country in order to support the deployment of FC-vehicles. China and South Korea are catching up rapidly. China considers fuel cells and hydrogen as central to its long-term science and technology development strategy[23,24,25] and also supports this strategy with substantial industrial involvement[26]; South Korea has the ambitious goal to supply 20% of the worldwide shipments of fuel cells by 2025 and offers subsidies of 80% of the costs of residential fuel cells for heat and power, gradually decreasing to 30% by 2020.

18 See e.g. U.S. Department of Energy: Effects of a Transition to a Hydrogen Economy on Employment in the United States. Report to Congress. July 2008. http://www.hydrogen.energy.gov/pdfs/epact1820_employment_study.pdf
19 U.S. Department of Energy: Hydrogen and Fuel Cell Program Plan 2011. pp. 5 and 28
20 Fuel Cell Today Industry Review 2010
21 U.S. Department of Energy: Hydrogen and Fuel Cell Program Plan 2011. p. 27
22 IPHE, 2011 Global policy update; http://www.iphe.net/docs/iphe_policy_update_120911_web.pdf
23 State Council of the PR of China: Long-term Science and Technology Plan (2006-2020).
24 Chinese Ministry of Science and Technology: 12th Five Year Plan for National Science and Technology Development (2011-2015)
25 Sun, G.: R&D Activities of Fuel Cells in China. 29 March 2012; see: http://www.climate-change-solutions.co.uk/pictures/content989/dr_shangfeng_du_-_uob.pdf
26 Fuel Cells Today: Hydrogen and Fuel Cells in China. 2012, p. 7

36. The growing investment in FCH R&D is reflected in the number of granted fuel cell patents in the field. Worldwide, this number quadrupled from 403 in 2000 to 1,801 in 2010. The majority of patents were granted to assignees in Japan (617) and the USA (598); Japan overtook the USA during this period to become the largest source of fuel cell patents[27]. Globally, Europe lags in the field in patents (321 patents in 2010, 60% of which in Germany).

37. Overall, public investment in R&D in Europe is comparable to its main competitors, although it is still somewhat fragmented. Coordination at EU level is of paramount importance to achieve effectiveness and efficiency of the R&D activities, and this has been one of the drivers to establish the FCH JU.

### 2.4. Several technological challenges need to be overcome

Despite the progress in the past few years, the level of performance, reliability, lifetime and cost required for a large-scale deployment in most applications has not been achieved yet and a sustained effort on RTD will be needed until 2020 to have these FCH-based solutions competitive with incumbent technologies.

38. In order to accelerate the market readiness and roll-out of fuel cell and hydrogen applications, several technological and cost-related challenges need to be overcome.

39. **Energy applications** for **power production** and **combined heat and power**. Current electrical efficiencies of the different Fuel Cells used are competitive with conventional alternatives (mainly gas turbines). The key factors that need further attention are energy efficiency, cost, system durability, and flexibility during operation.

40. **Transport applications**. Successful application in the automotive sector requires the combined deployment of fuel cell electric vehicles and hydrogen refuelling infrastructure. The cost of the fuel cells should decrease from more than 500€/kW in 2012 (based on only several hundreds of units produced per year) to approximately 50€/KW in 2020 in order to be competitive (based on mass-production of 500,000 units per year). At the same time, their lifetime should double from 2,500 hours now to 5,000 hours by 2020.

41. **Hydrogen refuelling infrastructure**. The deployment of affordable, efficient and safe hydrogen fuelling infrastructure is a critical step towards the mass-market deployment of FCH technologies. Approximately 200 hydrogen refuelling stations are already installed worldwide, of which one third is located in Europe. A hydrogen cost (delivered at refuelling stations) of less than 5 €/kg (corresponding to approximately 1€/litre of gasoline) is required for FCEVs to become competitive against other efficient solutions such as hybrid electric.

42. **Hydrogen production.** Hydrogen can be produced from various feedstock using conventional or renewable energy sources. Globally, 48% of bulk hydrogen is produced from natural gas steam reforming, 30% is oil-based, 18% is derived from

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27 Fuel Cell Today, Patent Review 2011; http://www.fuelcelltoday.com/media/948977/the_2011_fuel_cell_patent_review.pdf

coal gasification and the remaining 4% are obtained via water electrolysis. In the future, hydrogen should be produced through carbon-free or carbon-lean processes. Hydrogen from water electrolysis using renewable electricity (e.g. from wind turbines) or through biomass gasification may become dominant technologies in the future. Other promising technologies (e.g. low temperature solar, fermentation, photo-electrochemical processes) will still require substantial public support in view of post 2020 applications.

43. **Hydrogen as an energy storage medium**. With the increase of renewable energy in the European mix, producing hydrogen to store this intermittent and partially predictable source has emerged as a valuable solution. Hydrogen would be particularly suitable for long-term storage due to a higher energy density and potentially lower storage cost. Large scale demonstrations (at least 100 MWe) will be needed to showcase the feasibility and potential of this concept.

### 2.5. Underlying problem drivers

The underlying problem drivers are market failure for first movers, sub-optimal leveraging of available funding, and fragmentation and lack of critical mass.

#### *2.5.1. Market failure for first movers*

44. The full scale deployment and commercialisation of fuel cells is mainly hampered by (1) the high cost of fuel cells and (2) the lack of hydrogen distribution infrastructure. This makes it difficult for any player to move first. Without removing this **"chicken and egg" problem**, it will be difficult to progress.

45. More specifically, introducing radical change, competing against well-established, mature technologies and building the related infrastructures requires improving performance, lowering cost of all parts of the FCH chain and developing appropriate standards. The societal and environmental benefits that would result from these technologies cannot be "internalised" and monetised on the short term. There is as yet only a niche market for some early applications. In addition, Europe faces stiff competition from the US, Japan and Korea. All these factors increase the investment risk for "early movers" and are the substantial challenges for market introduction and a clear example of market failure. It will not be possible to overcome these challenges through market forces alone or dispersed public and private initiatives only[28].

#### *2.5.2. Need for leveraging of available funding*

46. The FCH JU funding for RTD and demonstration for the period 2008-2013 amounts to 940M€. According to estimates, this represents about 20% of total European funding – which is thus in the order of 5B€. In 2011, the JU Industry Grouping estimated that the required level of funding to implement their FCH Technology Roadmap should be around 17.9B€ between 2014 and 2020[29.] This includes both

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28 FCH JU Industry Grouping Financial and Technology Outlook 2014-2020

29 FCH JU Industry Grouping Financial and Technology Outlook 2014-2020, http://www.fch-ju.eu/page/publications

public and private contributions, with R&D and demonstration requiring 6.4B€ (3.3 for R&D and 3.1 for demonstration). Around 11.5B€ should be devoted to market introduction, of which 9.4B€ dedicated to transport (fuel cell vehicles and refuelling infrastructure). This is clearly beyond the public resources available for FCH research, both in the Framework Programme and in the Member States. A significantly increased leveraging of public funding will be needed to fully realise the objectives of the Roadmap.

47. The public consultation identified the difficult access to risk finance for deployment activities (82%) and limited public R&D funding (81%) as important problems.

*2.5.3. Fragmentation and lack of critical mass*

48. The European FCH sector is dispersed across different countries and types of organisations (major energy and transport companies, high-tech SMEs, research institutes and universities) which restricts the exchange and pooling of knowledge and experience. The research needed is often multi-disciplinary and complex, involving different cross-cutting sectors and no single company or research institution can perform it alone. The absence of a long-term, integrated RTD and market strategy and the sub-optimal leverage of funding leads to fragmented research coverage and discourages the industry and the research community from committing more of their own resources.

49. The FCH JU is a Pan-European public R&D programme with a budget of €940 million for 2008-2013, of which 470M€ EU contribution to be at least matched by participating legal entities. The FCH JU represents a public funding of approximately €75 million per year. The JU currently funds around 20% of European research activity in the field and between 10 and 20% of technological development and demonstrations[30].

50. The German National Innovation Programme (NIP)[31] on FCH Technology is comparable to the FCH JU in the deployment of resources (€1,4 billion for 2007-2016, 50% public funds, 50% private funds), with an obvious focus on support to German actors. Good connections exist between the JU and the NIP programmes to ensure complementarity. The NIP programme, presented in May 2006, aims at coordinating the different R&D government activities on FCH being undertaken by the Federal Ministry of Economics and Technology (BMWi) in the German Energy Research Programme with a set of new measures such as the preparations for commercialization carried out by the Federal Ministry of Transport, Building and Urban Development (BMVBS) in the framework of the Federal Government's Fuel strategy. This strategy was motivated by political priorities related to the increasing need for a secure and clean energy supply after the decision of phasing out the nuclear power plants and to stimulate knowledge-intensive industries in order to increase their competitiveness and to create jobs.

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30 First interim evaluation of the FCH JU http://www.fch-ju.eu/sites/default/files/EvalFuelCellHydroReport2011_ALLBROCHURE_WEB.pdf

31 http://www.iphe.net/docs/Meetings/Canada_5-11/Germany%20country%20update%20May%202011.pdf

51. Several other European countries are funding R&D of fuel cell and hydrogen technologies on a national level. The beneficiaries from these countries are also actively participating in the FCH JU. The national initiatives in the UK and France are currently increasing in scope and aligning their programmes with the FCH JU. The national programmes of Denmark, Italy, Sweden, Finland, Spain and Norway, although of high quality, are more limited in scope and/or size.

52. In the public consultation, 87% of the respondents believe that the industry cannot address the problems alone and 67% agree that Member States support will not suffice. An overwhelming 96% think that an intervention at EU level is required.

### 2.6. The importance of public intervention at EU level

53. Although the FCH sector has reached an advanced stage of innovation the industry sees it as still pre-mature and vulnerable. Carrying FCH technologies from the drawing board to full deployment in a global competitive environment requires a substantial increase in public and private investment in Member States and Associated Countries. Clearly, the 17.9B€ needed to implement the FCH Technology Roadmap for the period 2014-2020 is beyond the public means available in the EU for FCH research, both in the Member States and in the Framework Programme. However, a collective effort to fund a strategic part of this Roadmap in the FCH 2 JU will be a strong catalyser to leverage the additional private funding needed to close the financing gap.

54. The experience of the FCH JU shows that a long-term budget plan and roadmap based on commonly agreed strategic technical and market objectives provides stability and encourages industry, Member States, Regions and the research community to commit more of their own resources[32]. In the next programming period (2014-2020), complementarity also has to be ensured between Horizon 2020 and other EU instruments such as the EU regional policy[33][34] and the *Programme for the Competitiveness of Enterprises and SMEs (COSME)*. In particular, the Structural Funds could be better exploited for innovative public procurement and demonstrations of FCH technologies.

### 2.7. Achievements of the current Joint Undertaking

The FCH JU has put in place a significant project portfolio of strategic importance, with high industry participation, in particular SMEs.

#### *2.7.1. Bringing FCH technologies closer to the market*

55. The main objective of the existing FCH JU was to accelerate the market breakthrough of FCH technologies, and place Europe at the forefront of FCH technologies worldwide. Market introduction has indeed been achieved for some

[32] First interim evaluation of the FCH JU, op. cit., p. 4

[33] New Energy World Industrial Grouping (NEW-IG): Fuel Cell and Hydrogen technologies in Europe. Financial and technology outlook on the European sector ambition 2014-2020. 2011, p. 39

[34] European Commission: Synergies between FP7, the CIP and the Structural Funds. Final Report of the Expert Group. Directorate-General for Research and Innovation. Brussels, June 2011

early applications such as forklifts and small back-up power units. For both energy and transport applications substantial progress took place. As an illustration, between 2008 and 2012:

- The cost of PEM fuel cells has dropped on average by half (from 1,000 €/kW to 500€/kW) and their lifetime increased by 25% (from 2,000 to 2,500 hours);
- The cost of fuel cells for forklifts has dropped from 7,000 €/kW to 4,000 €/kW;
- The cost of storing gaseous hydrogen has been reduced from 1.0 to 0.5 M€/ton;
- The cost of hydrogen refuelling stations has dropped by 30% (today 0.7 to 2 M€ for capex depending on the quantity of hydrogen available).

Annex 6 provides a detailed overview of the achieved progress against the initial targets.

*2.7.2. A strong and strategic partnership at the forefront of FCH technologies*

56. The FCH JU has structured the R&D landscape in the FCH sector through the establishment of an industry led public-private partnership with a long-term perspective, combining the capacities of companies and research organisations, joint strategic research agenda, multi-annual plan and a long-term public and private commitment for funding. The present FCH JU groupings gather over 60 research centres and universities as well as over 60 companies, representing the core entities active in the sector in Europe.

57. The FCH JU has enabled the development of a strategic programme of activities as defined in the Multi Annual Implementation Plan (MAIP), comprising long-term, breakthrough-orientated research, applied research and technological development, demonstration and supporting actions, including strategic studies, pre-normative actions and technology assessment. More than 390 M€ in grants has already been allocated to about 130 projects (completed, on-going and under negotiation) and several of them can be considered as important success stories (see Annex 7).

*2.7.3. Leveraging effect*

58. The establishment of the FCH JU was expected to trigger from the industry an additional investment of 600M€ in RTD on top of their in-kind contribution to the FCH JU. The close to 80 private companies that have participated to the survey undertaken in the framework of the impact assessment have together reported an annual € 1,5 billion of expenditures in R&D and market introduction in 2011 or 2012, 36% seeing an increase of more than 10% annually since 2007. About 50% of the FCH JU Industry Grouping members state they have increased their R&D expenditures thanks to the existence of the JU, even during a period of severe economic and financial crisis, suggesting that the industry has taken their commitment very seriously. This illustrates that a public-private partnership with a mechanism such as a JU does improve the investment environment and can indeed trigger additional commitments.

59. The leveraging effect is also apparent from the funding rates of the JU, which have been lower than for FP7 due to the obligation of the legal entities participating in the projects to match the EU contribution. For example, an SME or a university that could claim a 75% reimbursement of direct cost plus up to 60% of indirect cost under FP7 has seen the EU contribution reduced to an approximate 50%-60% of direct cost plus 20% of indirect cost. As a consequence, the JU budget has allowed supporting a larger number of projects.

*2.7.4. Industry and SME participation*

60. Statistics of the Grant Agreements awarded by the FCH JU Calls (details in Annex 8) indicate several positive trends. The weight of the private sector in the applicant consortia has increased, indicating that the JU calls are more attractive to industry, particularly SMEs, than FP7. Industry (including SMEs) takes 66% of the funding compared to 47% in FP7. SME participation is significantly higher than in FP7: SMEs take 25% of the funding compared to 18% in FP7. These figures refer to the Energy Theme of FP7 in the period 2008-2012.

*2.7.5. Governance arrangement*

61. The Joint Undertaking for Fuel Cells and Hydrogen (FCH JU) was established by Council Regulation (EC) 521/2008 of the 30th May 2008 on the basis of Article 187 TFEU (Article 171 TEC) for a period up to 31 December 2017 when it shall be wound up. The FCH JU was conceived as a public-private partnership with 50/50 co-financing between the two original founding members, the European Commission and the Industry Grouping. Soon after the establishment of the FCH JU, the Research Grouping became a member. The contribution of all beneficiaries is taken into account in the 50/50 co-financing rule. The maximum EU contribution to the FCH JU is 470M€, covering running costs (up to 20M€) and research activities costs (450M€). This contribution is provided from the 7th Framework Programme budget allocated to 6 different Directorates in 3 Directorates General, DG RTD (330 M€ ), DG ENER (125 M€) and DG MOVE (15 M€).

62. During its first period of operation (transition phase), the FCH JU was mainly managed by the European Commission. Since November 2010 it is fully autonomous. The executive bodies of the FCH JU are the Governing Board and the Executive Director, supported by the Programme Office. There are three advisory bodies: the Scientific Committee, the State Representatives Group and the Stakeholders General Assembly. The present JU groupings gather over 60 companies as well as more than 60 research centres and universities active in the sector. This represents the bulk of the entities active in the sector in Europe. SMEs have a strong presence in the JU operations: 50% of the 60 companies of the Industry Grouping are SMEs. Two seats in the Governing Board are currently occupied by SMEs.

*2.7.6. Challenges with respect to complexity and cost-effectiveness*

63. JTI JUs were set up as innovative instruments under the 7$^{th}$ Framework Programme. The first experiences gathered with implementing the JTI instrument via the Joint Undertaking – own dedicated administrative structure – have highlighted a number of challenges with respect to complexity and cost-effectiveness, as noted by the

Sherpa report, the JTI interim evaluations, and the Court of Auditors reports on JTIs[35].

64. These challenges are mainly the lack of suitability of the general legal framework to the specificities of JTI JUs, the lack of options for tailoring in the JU establishment act, statutes, staff and financial rules and the delegation of the overall responsibility for the day-to-day management of the JU to the Executive Director. These identified shortcomings stem from the initial design and constitute a starting point for an improved design for the Horizon 2020 JTI JUs. The notable examples of the abovementioned shortcomings are presented in Annex 9.

## 2.8. Findings and recommendations from the Interim Evaluation

65. The interim evaluation, finalised in 2011[36] with the help of independent experts, concluded that the JU approach generally succeeds to enhance public-private activities in technology development and demonstration, and that the JU should be supported during the entire course of FP7 to implement its work as originally envisaged. The independent experts believed that there will be a need for continuation of this initiative. The technical objectives of the FCH JU were judged ambitious and competitive; the JU was perceived to provide stability for the R&D community given the cyclic nature of political interest and visibility: its presence is a reassuring "constant".

66. The experts identified some areas where operations could be improved. It endorsed the recommendations of the Sherpa report to streamline the legal framework and to review the current 'Community body' status that could reduce the administrative burden of such a small entity. It also noted that the Programme Office had insufficient technical resources for effective monitoring of the programme and portfolio management of the funded projects. As few projects have been completed so far, it was found difficult to assess the overall impact of the JTI mechanism alone in terms of new commercial products, patents or publications.

67. Furthermore, the experts made several recommendations regarding cooperation with Member States, international cooperation, and communication and outreach. These issues had received less attention in the take-off phase of the FCH JU. Several of these recommendations are currently being implemented. For example, the JU Programme Office has started developing international cooperation activities reaching a level similar to other energy areas. It has also developed a communication strategy and organised several events to promote the EU and the FCH JU programme. Outreach to key local and national actors (policy makers, enterprises, research organisations, multipliers, local authorities and press) is now also a priority area. Communication efforts at national level are being developed in close coordination with the State Representatives Group. Cooperation with Member States continues to be strengthened and widenend, in particular with Germany and the UK.

68. The Executive Summary of the First interim Evaluation of the FCH JU is presented in Annex 10.

35 http://eca.europa.eu/portal/pls/portal/docs/1/22482779.PDF
36 http://www.fch-ju.eu/sites/default/files/EvalFuelCellHydroReport2011_ALLBROCHURE_WEB.pdf

### 2.9. In summary: rationale for a FCH 2 Joint Undertaking

- Fuel cells and hydrogen can play an important role in combatting climate change and increasing Europe's energy security.
- Full deployment of these technologies could have large direct and indirect (e.g. automotive industry) economic effects (e.g. the creation of up to 200,000 jobs by 2030).
- But they are not yet fully deployed because for the moment they are not cost-competitive.
- Industry alone cannot address the technological challenge of reducing costs. This is because there are very high market risks associated with such a dramatic shift in energy systems which require the complex coordination of a many different actors. Also, firms cannot fully appropriate the environmental and security benefits flowing from their investment (market failures).
- These problems can only be tackled at the level of the single pan-European market – in other words, public intervention at individual Member State level is insufficient.
- Traditional collaborative research is insufficient as a tool for intervening at EU level. A JU is needed to reduce risks, to provide a stable budgetary framework, to develop and implement a sector-wide R&D strategy, and to ensure a clear industrial commitment to deployment.

## 3. OBJECTIVES

69. In abbreviated form, the general objectives of the *existing* FCH Joint Undertaking have been defined in the Council Regulation as follows:

- Aim at placing Europe at the forefront of FCH technologies worldwide and at enabling the market breakthrough of FCH technologies;
- Focus on developing market applications and facilitate additional industrial efforts towards a rapid early deployment of FCH technologies;
- Support the implementation of the R&D priorities of the FCH JU by awarding grants following competitive calls for proposals;
- Encourage increased public and private research investment in FCH technologies in the Member States and Associated countries.

70. The existing JU has successfully made important steps forward in reaching these objectives. For the proposed continuation of the FCH JU, the general objectives go in the same direction, but have been re-defined and re-focused. The new objectives take account of the widened scope and the emphasis on demonstration, innovation and support to activities on market introduction, and in recognition of the fact that the technology is getting closer to market.

## 3.1. General objectives

71. The general objective of the FCH 2 Joint Undertaking for the period of 2014-2024 is to develop a strong, sustainable and globally competitive fuel cells and hydrogen sector in the Union. This will allow supporting the EU policies on sustainable energy and transport, climate change, the environment and industrial competitiveness as embodied in the Europe 2020 strategy for growth, and help achieve the EU's overarching objective of smart, sustainable and inclusive growth.

## 3.2. Specific objectives

72. Ambitious objectives are needed to contribute to realising the FCH Technology Roadmap. The above general objective is therefore translated into the following specific objectives:

– Specific objective 1: Reduce the production cost of fuel cell systems to be used in transport applications, while increasing their lifetime to levels competitive with conventional technologies,

– Specific objective 2: Increase the electrical efficiency and the durability of the different fuel cells used for power production, while reducing costs, to levels competitive with conventional technologies,

– Specific objective 3: Increase the energy efficiency of production of hydrogen from water electrolysis while reducing capital costs, so that the combination of the hydrogen and the fuel cell system is competitive with the alternatives available in the marketplace, and

– Specific objective 4: Demonstrate on a large scale the feasibility of using hydrogen to support integration of renewable energy sources into the energy systems, including through its use as a competitive energy storage medium for electricity produced from renewable energy sources.

73. The specific objectives have been defined collectively by the Industry Grouping in consultation with the Research Grouping. The four specific objectives address the main priorities of the Technology Road Map 2010-2020 proposed to the FCH JU Governing Board by the Industry Grouping and adopted by the Steering Group of the SET Plan. The target values set in each of these objectives have been defined using a "market-gap" approach based on the assessment of the existing baseline and track records available as well a comparison of targets for incumbent competing technologies. The updated MAIP of the FCH JU will have a higher number of specific targets related to the above-mentioned specific objectives.

Based on the progress achieved so far and on the developments in other world regions (e.g. US, Asia), the concerned Commission services (RTD, ENER and MOVE) consider that these objectives are achievable provided the level of EU funding is maintained, the industry commitment (inside and outside the normal calls) at least matches the EU contribution, and synergies are developed with other activities under Horizon 2020 (e.g. FET, ERC, European Green Vehicles Initiative) and the Structural Funds.

In addition, the following *operational objectives* have been defined, to be reached by 2020:

- Operational objective 1: Leverage private and public (including Member States) investment for R&D and innovation on FCH technologies worth at least two times the size of the EU contribution.

- Operational objective 2: Maintain, and if possible increase, SME participation in the JU's activities at or over the current 25%.

- Operational objective 3: Unlock the excellence and innovation potential in Member States and Regions – in particular those benefitting from the EU Structural Funds - in the field of FCH technologies through their hosting of FCH JU demonstration projects.

- Operational objective 4: Ensure the efficient implementation of the FCH JU programme by substantially shortening the time-to-grant and time-to-pay.

## 4. POLICY OPTIONS

74. In this section, policy options for organising research and innovation on fuel cells and hydrogen during the next programming period 2014-2020 are presented. The different options are compared in Table 1. The "no-EU action" option to discontinue public research funding at European level is discarded. The "no-EU action" is appropriate where technologies are either sufficiently mature to enter the market or are unlikely to have sufficient Europe-wide impact, and this does not apply to fuel-cells and hydrogen. FCH technologies are a key to sustainable energy and transport systems, and can contribute significantly to achieving the objectives of the EU energy policy, the Energy Roadmap 2050 and the Europe 2020 strategy for growth. The Commission proposal on Horizon 2020 therefore envisages activities supporting FCH technologies under the Societal Challenge "Secure, clean and efficient energy".

### 4.1. Options

75. Within the Horizon 2020 framework, four policy options are concretely available:

- Continuing the Fuel Cell and Hydrogen Public-Private Partnership in the **current form (Joint Undertaking)** within Horizon 2020. This is the Base-Case scenario against which all other options are being assessed;

- Using **collaborative research** projects under the EU Framework Programme Horizon 2020, thus not prolonging the current FCH JU;

- Implementing Horizon 2020 for the fuel cell and hydrogen technologies through a **Contractual Public-Private Partnership;**

- Implementing a Fuel Cell and Hydrogen Public-Private Partnership through a **modernised Joint Undertaking** adapted to Horizon 2020.

The policy options differ when considering their:

- **Scope** (balance between research, demonstration, support to early deployment, transport and energy applications, energy storage);

- **Governance** (level of coordination between the industry and research community, between transport and energy actors and between MS and the EU);

- **Modus operandi** (funding rates; simplicity of access to funding; efficiency of the programme implementation);

- **Stability** (continuity provided both on the policy and financial side; the more stable the 'environment', the more likely the private sector, in particular SMEs, will invest in R&D in the FCH sector and the more likely the MS will align with the EU programme. This will be directly reflected in attaining a higher leverage effect, critical mass and wide participation of SMEs).

*4.1.1. PO1 - Fuel Cell and Hydrogen Public-Private Partnership in the current form (Joint Undertaking) within Horizon 2020 (Business-as-Usual)*

76. The base-case (or business-as-usual) scenario relies on the continuation of the JUs under Horizon 2020 as they currently exist under the 7$^{th}$ Framework Programme, i.e. retaining their current scope of objectives, governance (same division of powers and responsibilities between the Executive Director, the Governing Board, the Commission, and the private participants) and their current modus operandi (financial rules, funding rules, etc.).

77. Regarding the funding rules, derogations from Horizon 2020 Rules for Participation will be required in order to maintain the status quo.

78. PO1 will prolong the stability provided by a public-private partnership with a long-term perspective, joint strategic research agenda, multi-annual plan and a long-term public and private commitment for funding.

*4.1.2. PO2 - Use of collaborative research projects under the EU Framework Programme Horizon 2020, thus not prolonging the current FCH JU (Zero Option)*

79. Modus operandi: the R&D would be implemented through the standard funding schemes of the EU Framework Programme and, separately, through national and regional programmes. It is a well-established mechanism, proven over time and well-understood by industry and the research communities. It is efficient and well-managed with clear objectives and expected impacts, has a traditional emphasis on scientific quality and innovation, a mature approach to technical follow-up and financial auditing, and a respected peer review process. In the spirit of simplification, the rules for participation and dissemination of Horizon 2020 would *de facto* be applied to all FCH projects. In particular, the funding rate would be re-aligned with other programmes of Horizon 2020 and would be higher than in the current FCH JU.

80. Governance: Comitology would be re-introduced. The implementation of demonstration projects targeting the societal, economics and environmental objectives within the energy and transport sectors could become fragmented, as they are distributed over several services and overseen by different Programmes Committees, each with different priorities. The industry and research actors would no

longer be in the driver seat for defining the programme priorities and timelines, even if a consultation mechanism such as a European Industrial Initiative or a Technology Platform would be established.

81. Stability: EU public support would again depend on annual or biennial budgets and work programmes, and would not be guaranteed.

82. Scope: The industry and research stakeholders would be asked to advice in an *informal* way on the programme's scope and objectives. Member States may have easier insight into – and influence on - the successive work programmes through their participation in a Programme Committee.

*4.1.3. PO3 - Implement Horizon 2020 for the fuel cell and hydrogen technologies through a Contractual Public-Private Partnership*

83. Modus operandi: Within a Contractual Public-Private Partnership, the Commission services or an executive agency would manage projects in the framework of successive work programmes. A contractual arrangement for the PPP between the European Commission and the relevant stakeholders would be signed. Private partners will not contribute to the administrative costs for a programme office, but the commitment to the research agenda would have to be made explicit.

84. Governance: Comitology would be re-introduced. Portfolio management of funded projects towards common goals would become more difficult. A Contractual Public-Private Partnership would allow a good level of collaboration both within the different EC services and between the EC and its partners, but these services would manage their programme separately, and launch separate calls for proposals, which will multiply the potential access paths to funding for potential beneficiaries.

85. Stability: a constant, stable level of EU public support for FCH technologies could not be guaranteed as the budget would be subject to an annual decision, even if an overall budget for the period 2014-2020 would be indicated.

86. Scope: the industry and research stakeholders would be asked to advice in a *formal* way on the programme's scope and objectives, but would not co-decide and not be in the driver seat.

*4.1.4. PO4 - Fuel Cell and Hydrogen Public-Private Partnership through a modernised Joint Undertaking adapted to Horizon 2020*

87. Modus operandi: The modernised JU option builds upon the past experience and the lessons learned and it further improves the design and suitability of the instrument to the new challenges under Horizon 2020 by simplifying the administration, introducing lighter financial procedures, exploring possibilities of establishing common services/functions, and increasing stakeholder dedication to the JU. The modernised JU keeps the basic elements of an EU body: legal status, application of the Staff Regulations, application of the Protocol on Privileges and Immunities, liability, jurisdiction and applicable law, protection of the financial interests of the Members, rules on confidentiality and transparency. At the same time the modernised JU simplifies a series of other important elements: reference to the PPP-specific financial rules, harmonized provisions on control and audit, application of

the Horizon 2020 rules (subject to eventual derogations where appropriate), set-up under the responsibility of the existing JUs, no mandatory host agreement, streamlined financial and operational planning and reporting, and harmonized approach to internal audit.

88. Governance: In the future legal environment tailored-made for the JUs, the modernised JU could contribute to improving the shared programme governance, providing a stable long term perspective to the stakeholders and simplifying the administration and operations of the JU. The modernised JU would keep the basic elements of the Statutes such as the JU bodies and their responsibilities, but would allow strengthening the coordination with Member States and Regions. Regions might become a permanent observer in the States Representatives Group. Furthermore, the role of the States Representatives Group is planned to widen in the new Regulation to include coordination, and not only advising the JU. Both MS and Regions will be important for securing additional funding for demonstration projects through Structural Funds.

89. Scope: A modernised JU will allow a re-orientation of the objectives and activities of the FCH JU, structuring the programme around two main innovation pillars, respectively dedicated to Transport and Energy Systems, and one cluster of cross-cutting research activities. This would allow putting more emphasis on energy applications, hydrogen as a storage medium, and a variety of activities to support market introduction. It would also allow putting more emphasis on large scale demonstrations. The reorientation of activities, in particular by increasing the support to demonstration and market introduction, is expected to trigger additional industry funding to accelerate full deployment of FCH technologies.

90. Stability: PO4 will provide a stable public-private partnership with a long-term perspective, joint strategic research agenda, multi-annual plan and a long-term public and private commitment for funding.

### 4.2. Budget allocation

91. The four options will be compared assuming the allocation of the same overall EU contribution, which is based on the Horizon 2020 proposal, and amounts to maximum €700 million. The EU contribution is further justified in section 6.5.

Table 1. Comparison of the policy options

| | **Option 1**<br>**Continuation of current JU** | **Option 2**<br>**Horizon 2020 – collaborative research** | **Option 3**<br>**Contractual Public-Private Partnership** | **Option 4**<br>**Modernised JU** |
|---|---|---|---|---|
| Multiannual budget commitment by the EU | Yes | No | Indicative budget. Not legally binding | Yes |
| Support activities for innovation and early deployment | Limited as in FP7 | As in Horizon 2020 | As in Horizon 2020 | As in Horizon 2020<br>5-10% of budget allocation |
| Support to research activities | 50-55% of budget allocation | R&D and demonstration ratio can be defined annually | R&D and demonstration ratio can be defined annually | 30-40% of budget allocation |
| Multiannual Strategic Research Agenda | Defined by Industry and Research Groupings. Decided jointly with the Commission | Advised by Technology Platform and/or Industrial Initiative. Decided by EC through comitology | Defined through PPP consultations. Decided by EC through comitology | Defined by the Industry and Research Groupings. Decided jointly with the Commission |
| Structure of Multiannual Strategic Research Agenda | 5 application areas, incl. cross-cutting | Horizon 2020 societal challenges | Horizon 2020 societal challenges | Clustering of application areas into 2 axes (energy and transport), plus cross-cutting, in line with Horizon 2020 societal challenges |
| Role of Member States | As with the current State Representatives Group (SRG) | Programme Committee | Programme Committee | SRG with a greater possibility to contribute (joint actions) |
| Implementing body | Joint Undertaking, Programme Office | Commission/Executive Agency | Commission/Executive Agency | Joint Undertaking, Programme Office |
| Funding mechanism & rates | Matching rule (50/50 co-funding), with assessment of in-kind contribution | Horizon 2020 funding rates | Horizon 2020 funding rates | Horizon 2020 based funding rates |

## 5. ANALYSING THE IMPACTS BY POLICY OPTION

92. The four Policy Options identified and presented in Chapter 4 are compared using a set of criteria described in the sections below. It should be noted that, FCH being a new technology, some impacts can only be described qualitatively rather than quantitatively. The opinion of the stakeholders and of the respondents to the public consultations on the expected impact of the Policy Options is presented in Annex 11.

### 5.1. Well-designed intervention logic

93. PO1 and PO4 offer the best opportunity to develop a logical and coherent intervention in both the technical and organisational dimensions. The institutional arrangements of the JU permit industry and the Commission services to design a strategic agenda over an extended period, backed by known and adequate, secure funding. PO3 also allows industry intervention in the design of the programme logic and substance, but with a lower sense of ownership and, above all, no secure funding. The overall objective of the intervention is to develop technologies to market readiness. The actors best-placed to identify the necessary actions are the industrial partners. The JU mechanism is the best suited for that purpose, as shown by the high industry participation in the current JU (Industry accounts for 66% of the funding, to be compared to 47% in FP7).

### 5.2. Leveraging effect on deployment

94. The modernised JU (PO4), with its increased support to demonstration activities, hydrogen (production, storage and distribution) and market introduction - which is a main feature differentiating it from the existing JU (PO1) - is best placed to trigger the required additional funding for full deployment of FCH technologies. According to the FCH Technology Roadmap, in excess of 11B€ will be needed for full deployment of FCH technologies, in particular in the field of hydrogen infrastructure. This is several orders of magnitude higher than what the Framework Programmes can put on the table.

### 5.3. Critical mass

95. The scale and scope of the FCH research agenda goes beyond the capacity of individual Member States, both in terms of financial commitment and of the research capacity involved. In addition, the relatively fragmented nature of the European scientific community necessitates institutional scaffolding around which a critical mass can assemble. The establishment of a PPP in FCH research is intended to bring together a critical mass of researchers and industrial actors to address obstacles to commercial deployment. The current JU has answered to this need, as it has established a central focal point from which coalitions can be built, allowing companies in other regions to find and connect to JU members, and it provides "one strong voice to policy makers and stakeholders abroad".

### 5.4. Small and medium-sized companies

96. SMEs are often unable to make their own way along the value chain and need support from the large, global companies. The opportunity to work within a strong,

international institutional context can support the dissemination of innovative ideas to those that can bring them to mass markets. The more stable arrangements of PO1 and PO4 are best placed to provide an environment conducive to the uptake of innovative practice and the incorporation of innovative actors into future value chains. The high participation of SMEs in the current JU, receiving 25% of the funding as compared to 18% for FP7, confirms this aspect. The simplification of procedures in the Horizon 2020 options can be especially beneficial for SMEs. This places PO2, PO3 and PO4 - ahead of PO1. Furthermore, PO4 would allow - in contrast to PO1 - access to the Guarantee Fund. PO4 is therefore the best option to achieve the objective of maintaining, and if possible increasing, SME participation in the JU's activities at or over the current 25%.

### 5.5. Innovation

97. Horizon 2020 is intended to stimulate innovation through continuous support along the innovation chain from the idea to the market. This will put emphasis on result-oriented research, dissemination, piloting and demonstration, strengthened provision for market take-up, funding along the innovation chain and supporting demand-side measures. PO4 will have a broader scope to put more emphasis on demonstration, and specifically include actions to support innovation and market-uptake.

98. An important pre-condition for innovation will be the access to venture capital schemes for activities with high technical and market risks, such as the Risk-Sharing Finance Facility (RSFF) and CIP financial instruments developed under FP7. Access to these and other improved sources of finance would be facilitated in all policy options that operate under the rules of Horizon 2020, but the opportunities will be greatest where there is a clear research agenda and institutional focus that situates the venture capital investment in a convincing, wider commercial context. Balancing these aspects, PO4 is the most attractive option; PO3 is superior to PO2 as it has some element of strategy and continuity; PO1 can provide a degree of strategy and continuity, but only access with more difficulty the new tools.

### 5.6. Economic growth and competitiveness

99. The impacts on economic growth and competitiveness will depend strongly on whether European companies establish a leading position in the field. The impacts on employment and growth may be positive, but not dominant in case jobs gained in the FCH industries will be matched by losses in the traditional industries that they replace. A major contribution to growth in GDP and employment therefore will be achieved only if European companies establish a strong export market; in this respect first mover advantages may be significant. The broader scope of PO4, with more emphasis on demonstration and support to market uptake, is best placed to accelerate the time-to-market.

100. Creation of a leading position in a future market requires establishing common norms and standards. This is particularly relevant to the development of a hydrogen infrastructure, which is unlikely to develop at the desired pace if left entirely to commercial motivation; the first mover risks will outweigh first mover benefits. The coordination of policies, regulations and standards across the energy and transport sectors and across European member states, together with the finance and deployment of infrastructure cannot be achieved by the R&D programme or by the

efforts of the JU alone, but the JU can be an effective interlocutor and lobby for the necessary administrative and political actions. PO4, with its broadened scope, is best placed to contribute to the development of a hydrogen infrastructure by supporting demonstration at large scale of the feasibility of hydrogen as a competitive energy storage medium, and by activities to support early deployment.

### 5.7. Coherence of the knowledge triangle

101. One of the aims of Horizon 2020 is to improve the coherence of the knowledge triangle comprising research, innovation, and training. Fostering innovation and training of researchers has substantial relevance to the FCH programme, because financial support is needed to bring scientific ideas into commercial practice. This is particularly true for SMEs, for whom training may be otherwise excessively costly. Of all policy options, PO4 will be best placed to extract maximum benefit because it can integrate these other tools into the research programme with assured funding.

### 5.8. Broader policy coordination

102. The linkage of Horizon 2020 to societal challenges facilitates the development of strong connections with sectorial policies. This will be important in commercialisation, because there needs to be strong regulatory and policy interventions in order to reflect, in the market prices, the economic and societal benefits of the technologies. There may also be opportunities to seek support for the provision of infrastructure, from cohesion funding. Under this criterion all policy options based on Horizon 2020 would benefit, but this would be seriously off-set in the case of PO2 by the absence of an institutional interlocutor. To some degree the same would apply to PO3; PO4 does best by this criterion.

### 5.9. Coherence with programmes of Member States

103. During the first years of operation of the FCH JU, the main focus was to engage Member States in the operation of the JU through the States Representatives Group. Although the FCH JU has had a positive influence and contributed to the inclusion of FCH technologies in the Energy R&D programmes of MS, links with the JU activities in complementary and synergetic ways were not systematically exploited with the exception of Germany. This MS has developed a very ambitious FCH programme, comparable in budget and scope with the FCH JU. Concerning Regions, the JU was fundamental in the establishment in 2008 of the 'Hydrogen Fuel Cells and Electromobility for European Regions' ("*HyER*")[37], which offers a platform for the increasing role of regions in strategy, policy, deployment and funding decisions concerning the roll-out of economically and environmentally sustainable vehicles and refuelling/recharging infrastructure. HyER represents over 30 regions and cities in Europe and actively participates in several FCH JU and FP7 projects.

104. Looking towards the future, the FCH JU will aim not only to a better alignment and coherence of the national, regional and JU programmes but to foster jointly funded actions, including smart specialisation in regions and the use of Structural Funds. All the proposed options allow for the participation of Member States and Regions if they so desire, but the options PO1 and PO4 that include a long-term strategic agenda

[37] http://www.hyer.eu/

and a budget commitment will permit a more focused effort. In particular for PO4, it is expected that as energy applications in the modernised JU activities increase in scope due to the need to store renewable electricity in all MS, this will attract more attention, and promote coordination and synergies between national programmes.

## 5.10. Cost efficiency

### *5.10.1. Cost neutrality and JUs as effective means to achieve goals*

105. The first experiences with the JUs indicate that they constitute a highly effective means of implementing the 7th Research Framework Programme. The use of a JU to implement the JTI has the following main benefits compared to using the standard means of implementation of a framework programme:

- a clear commitment of the stakeholders;
- visible legal, contractual and organisational framework to structure the specific joint commitments to which stakeholders are ready to sign up;
- firm governance structure for the JU, including shared decision-making powers and management by the public and private partners, is visible to all stakeholders;
- budgetary certainty via the budget ceiling for EU contribution to cost of the operations and the private partners' financial commitment;
- efficient use of public resources as the Commission passes operational roles to the JU while retaining focus on regulation and supervision.

106. Furthermore, the use of a JU to implement the JTI with the current small-sized body is already at least cost neutral and probably more cost-effective for the Commission, as shown by the cost-benefit analysis performed in-house DG RTD, in comparison to collaborative research initiatives and Contractual PPPs in terms of administrative, supervision, establishment and winding up costs because the private partner pays 50% of the running costs of the JU. Increasing the size of operations of the JUs and simplifying their functioning on the basis of common participation rules for Horizon 2020 will make the JU a cost-effective means of implementation.

### *5.10.2. Possible improvements - efficiency*

107. The "business-as-usual" scenario, which is one of the considered methods of implementing JUs under Horizon 2020, relies on the continuing of the JUs under Horizon 2020 as they currently exist under the 7th Framework Programme. In contrast, the "modernised JU" option simplifies and improves the legal framework, governance, and operational modalities of the current JUs. In particular, in order to ensure a good balance between cost-neutrality of the JUs under Horizon 2020 and increase their cost-effectiveness, the following simplification measures are being considered:

- Foreseeing a single set of Rules for Participation and Dissemination that will, subject to derogations where appropriate, render participation easier and ensure a single and sufficiently flexible regulatory framework, will create a more coherent set of instruments covering both research and innovation and increase the scientific and economic impact while avoiding duplication and fragmentation.

- Introducing lighter financial procedures, which in particular will provide simplified procedures for the establishment and the adoption of the budget and corresponding reporting._This is due to the new Financial Regulation which permits bodies like JTIs adopt lighter financial rules based on a new, tailor-made, simplified "model" Financial Regulation.

- Using common IT systems, including the proposal evaluation system for Horizon 2020, increases harmonisation, reduces the costs for such services and allows JU staff to better adapt to the common software management programme. Moreover, by using the "commons" of the programme, the JUs coordinate better their internal processes regarding portfolio management, as well as monitoring and reporting towards the legislator and the Commission regarding management of programmes and projects.

- Exploring different options regarding establishing common services/functions (IT, Audit, Legal issues) for PPP/JTIs. These options are:

  (a) Commission provides common services to JUs and requests from them the payment of a proportional contribution;

  (b) JUs set up their own common functions, which are specific and shared among them; for example in the context of the internal audit or for the accounting officer (the latter case being explicitly provided for by the Rules of Application (RAP), Service Level Agreements, common service and supply contracts and exchange of information among JU colleagues.

  (c) Each JU organises itself individually.

- Continuity of staff between the current and future JUs for the period when the current project portfolio is closed down and the future portfolio is build up.

*5.10.3. Possible improvements - effectiveness*

108. At the same time, the above simplifications envisaged for the new JUs to be set up under Horizon 2020 will also allow them to become more effective by:

- Clear stakeholder commitment to the JTI through (1) a definition, in a dedicated annex to the regulation, of the contribution to the JTI of industrial members, rendering their contribution more visible, (2) improved representation of the public and private partners in governing bodies, (3) a balance of influence between the Commission and Industry in the appointment of the Executive Director, etc.).

- Introducing more flexible budgetary and procurement procedures through adjusted legislative framework building on the new Financial Regulation.

- Increasing the accessibility of the programmes. The Horizon 2020 JUs shall apply the common set of rules of the Horizon 2020 Rules for Participation, thus providing a coherent legal framework. Any derogation requested by the JU would have to be duly justified for specific needs and should be cost-effective for the implementation of Horizon 2020.

# 6. Preferred Policy Option

## 6.1. Comparing the impacts

109. The table below assesses the impacts of each option according to the discriminating criteria used in Section 5. The criteria have been grouped to indicate those that reflect best the three high-level criteria of effectiveness, coherence and efficiency. A plus sign indicates an improvement over the existing reference arrangement that is taken to be the continuation of the existing JU (PO1); a negative sign indicates less good performance and an equal sign indicates equality.

| Criteria | PO1 JU under Horizon 2020 – current form | PO2 FP under Horizon 2020 | PO3 Contractual PPP | PO4 JU under Horizon 2020 – modernised form |
|---|---|---|---|---|
| ***Effectiveness*** | | | | |
| Intervention logic | = | - | - | = |
| Leveraging effect | = | - | - | + |
| Critical mass | = | - | = | + |
| SMEs | = | = | = | + |
| Innovation | = | - | + | + |
| Economic growth and competitiveness | = | - | = | + |
| ***Coherence*** | | | | |
| Coherence of the knowledge triangle | = | + | + | + |
| Broader policy coordination | = | - | = | + |
| Coherence with programmes of MS | = | - | - | + |
| ***Efficiency*** | | | | |
| Cost-efficiency | = | - | = | + |
| Operational simplicity | = | + | + | + |

Table 2 Comparison of options

110. Compared to the existing JU (PO1), the modernised JU (PO4) has a similar clarity of focus and broadly equal intervention logic; both these options are superior to the alternatives that lack the assurance of long-term funding and strategic orientation from industrial leadership. The JU-type options will achieve a stable critical mass along the FCH value chain at programme and project level, with agreed priorities and directions. In this respect they are preferable to the options with less focused partnerships and priorities, i.e. the Horizon 2020 "only" option (PO2) and to a lesser extent also the Contractual PPP (PO3).

111. PO4 offers some improvements to the existing arrangements. For example, the easier access to support for innovation and the simplification of mechanisms are likely to benefit SMEs in particular. The existence of a strategic partnership under both PO1 and PO4 is beneficial to the development of good relationships between the SMEs and big companies, which is likely to contribute also to effective commercial value chains. PO4, which can address early deployment support actions, promises to offer better integration of research results into the policy and regulatory domain and this in turn will help in the deployment of FCH technologies through well-designed regulatory instruments. PO4 may actually have a self-enhancing effect on innovation.

### 6.2. Efficiency in addressing the underlying problem drivers

The options based on a Joint Undertaking (PO1 and PO4) are the most efficient in addressing the underlying problem drivers, i.e. alleviating market failure, leveraging available funding and providing a critical mass. Firstly, shared governance between industry, the research community and the EC allows for close coordination and prioritisation of the R&D programme. This helps to create the right products, applications and standards to be competitive in a global market. Secondly, a long-term budget plan and roadmap provides stability and encourages industry, Member States and the research community to commit more of their own resources. Looking towards the programming period 2014-2020, the private sector involved in the current JU expects to invest at least 5B€. Thirdly, the members of the FCH JU groupings form the core entities active in the sector in Europe. This represents a critical mass; a focal point from which coalitions can be - and have been - built, and which can communicate with a single strong voice.

112. Since PO4 is the only option that provides support to market introduction activities, it is best suited to attract further leverage for the deployment actions from industry and other stakeholders. Furthermore, it provides a stable critical mass along the FCH value chain, including infrastructure and hydrogen providers, which facilitates the simultaneous coverage of technology and infrastructure development, thus contributing to solving the chicken-and-egg problem.

### 6.3. Preferred Policy Option

113. From the analysis and comparison of the different impacts by Policy Option it can be concluded that PO4 is either superior or equal to PO1 and PO3 by all criteria, essentially because of its stability and the strategic relations that it permits across the board. PO4 is also generally superior to PO2 in terms of effectiveness. Importantly, PO4 is also the most efficient option to address the underlying problem drivers.

114. This analysis is strongly supported by the stakeholders. The stakeholder survey shows that 93% of the beneficiaries are in favour of continuation of the JU. The responses from the Industry Grouping in particular unambiguously identify the modernised JU (PO4) as having the strongest impact. This is underlined by the results from the public consultation, showing that a convincing majority of respondents favour the continuation of the JU in a modernised form, i.e. PO4 (see Annex 11, Figure 6).

115. Central to this analysis is the assumption of the solid financial commitment of the private sector in addition to the EU funding, which is a precondition for providing stability, leverage and strategic direction, thus reaping the full benefits of PO4.

### 6.4. Implementation and governance

#### *6.4.1. Programme structure*

116. In its Financial and Technology Outlook for the European FCH sector, the Industry Grouping has described the technology development steps that will be followed until 2020 to bring the different applications to market (see Annex 12). The detailed content of the JU programme is being defined in the Multi Annual Implementation Plan (MAIP).

117. The implementation of the FCH JU programme of research, development and demonstration for fuel cell and hydrogen technologies for the period 2014 – 2020 is structured around **two main innovation pillars**, respectively dedicated to Transport and Energy Systems, and one **cluster of cross-cutting research activities**, complementing the technical research activities. The two innovation pillars have an

area of overlap (integrated energy and transport systems). Figure 1 lists the specific FCH applications for the two innovation pillars as well as the overlapping area.

**Innovation pillar 1: FCH Technologies for Transportation Systems**

- Road vehicles
- Non-road mobile vehicles and machinery
- Refuelling infrastructure
- Maritime, rail and aviation applications

| | RTD&D Area | Specific Application | Priority Level | |
|---|---|---|---|---|
| TRANSPORT | Road vehicles | Cars, taxis, Light Commercial Vehicles (LCV) | Hign | |
| | | Buses | High | |
| | | Heavy Commercial Vehicles (HCVs), incl. APUs & TRUs | Medium | |
| | | Municipal Vehicles (eg Refuse Collection Vehicles, sweepers) | Low | |
| | | 2-wheelers & other light vehicles | Medium | |
| | Non-Road vehicles and machinery | Material Handling Equipment | Medium | |
| | | Airport ground handling support | Low | |
| | | Construction & Mining | Low | |
| | | Agriculture Ground-care | Low | |
| | | Rail & light rail | Low | |
| | Maritime & Aviation | APUs for commercial aircrafts | Medium | |
| | | APUs for ships | Medium | |
| | | Propulsive power for light aircraft & Unmanned Aerial Vehicles | Low | |
| | | Propulsive power for Boats and ships | Low | |
| | Refuelling infra structure | Public/retail H2 refueling stations | High | Integrated Energy & Transport systems |
| | | Industrial, municipal and Fleet depots | High | |
| | | Distributed reforming & electrolysis | Medium | |
| | | Liquefaction | Medium | |
| ENERGY | Hydrogen production and distribution | Innovative technologies for H2 production | Medium | |
| | | Waste H2 recovery and use | Medium | |
| | | RES H2 storage and distribution | High | |
| | Hydrogen for renewable electriciy integration | Electrolysis for intermittent RES power | High | |
| | | Hydrogen delivery in the natural gas grid and end-users as HCNG | High | |
| | | Large scale long term strorage | High | |
| | | RES hydrogen integration in electricity grid | High | |
| | Stationary Power and Heat | Industrial and large commercial power, CHP & CCHP | High | |
| | | Community and district CHP & CCHP | Medium | |
| | | Domestic & small commercial CHP | High | |

Figure 1. Innovation pillars and building blocks of the FCH JU programme

**Innovation pillar 2: FCH technologies for Energy Systems**

- Hydrogen production, storage and distribution, including through gas networks
- Hydrogen technologies for electricity storage and grid balancing
- Heat and power generation with stationary fuel cell systems for residential and industrial uses
- Mini, micro and portable fuel cell systems

118. The integration of a large share of intermittent renewable sources in the electricity production mix is considered as one of the most crucial issues of the transformation into a low-carbon energy system. Therefore, the development of efficient and cost competitive solutions for storing renewable electricity in large quantities and for a longer term is one of the main priorities of the EU energy policy. Using hydrogen as a medium to store this electricity is one of the possible options, since hydrogen has a great potential for storing large quantities of renewable electricity. The advantages of hydrogen storage over conventional energy storage technologies include its higher energy density and potentially lower storage cost, its flexibility for other off-grid end uses like fuel in fuel cell electric vehicles, its utility as an industrial gas and the power-to-gas storage and distribution easiness. For that reason, the use of hydrogen as a storage medium, its distribution through the existing natural gas infrastructure and its potential grid and off-grid applications will be an important priority of the FCH JU, directly addressing the societal challenge of improving energy security.

**Cross-cutting part:**

- Social acceptance and public awareness issues;
- Education and training for FCH sector scientists, engineers, technicians and decision/policy makers outside the sector;
- Policy and strategy development;
- Pre-Normative Research;
- Regulations, Codes and Standards, including safety standards and norms.
- Identification and developments of investment and financing mechanisms and structures

119. Over the whole FCH JU period duration from 2014 to 2020, research and development should account for 30 to 40% of the total effort while 40 to 60% of the effort is expected to be devoted to demonstration and pilot activities, reflecting the fact that hydrogen and fuel cell technologies are approaching market introduction. In line with the current FCH JU characteristics, it is proposed to dedicate 5 to 10% of the JU total budget to complementary cross-cutting research activities, including support to market-introduction of market-ready applications.

| Activity distribution | R&D | Demonstration |
|---|---|---|
| Transports Systems | 15-20% | 20-30% |
| Energy Systems | 15-20% | 20-30% |
| Cross-cutting (incl. early deployment) | 8-12% | |

Table 3. Indicative distribution of the FCH JU budget

### *6.4.2. Relation to Horizon 2020 activities outside the FCH JU*

120. Although the FCH JU is the principal instrument for joint European FCH research, it should maintain an effective interaction with related activities in Horizon 2020. For example, the JU shall develop synergies with the Future Emerging Technologies (FET) activities and the activities of the European Research Council (ERC) in the "Excellent Science" priority. Similarly, research on key enabling technologies (KET) such as materials, nanotechnologies and processes will be carried out in the "Industrial Leadership" priority. It will also be important to build/strengthen relations with transport and energy-related initiatives at European level, such as the SET-Plan Industrial Initiatives (wind, solar, grids) or the transport PPP (European Green Vehicle Imitative). Furthermore, ERA-NET and the EERA Joint Programme on FCH can coordinate and integrate national and regional activities in the field, and can be effective partners for the JU.

### *6.4.3. Governance and operations*

121. In line with the current structure, the FCH JU Programme is implemented by a dedicated Programme Office, under supervision of the FCH JU Governing Board (GB). The GB consists of representatives of the three members. The distribution of seats changes slightly compared to the current FCH JU; the NEW-IG keeps six seats, the EC reduces from five to three seats and N.ERGHY keeps one seat.

122. The main task of the FCH JU Governing Board is to oversee the proper execution of the research and innovation programme in line with strategic and specific objectives. From the experience of the current FCH JU, it is strongly recommended that the GB should be as much as possible relieved of daily administrative and management decisions, which should be entirely within the Programme Office Executive Director's province. The GB will elect its chair and the vice-chair.

123. The Governing Board will translate the strategic objectives of the FCH JU into a Multi Annual Implementation Plan (MAIP) and Annual Implementation Plans (AIPs), and will oversee the delivery of the JU Programme. The MAIP and AIPs will constitute the principle business documents of the FCH JU. The MAIP may be revised over the lifetime of the FCH JU. The AIPs will be drawn up annually and will reflect the priorities of the FCH JU. Both documents will be established by the three partners in the Governing Board, with input from other stakeholders, including the Scientific Committee and the States Representatives Group.

### 6.5. Proposed budget for the option of choice

124. The proposed activities of the modernised JU show a re-orientation towards more demonstration, more emphasis on energy applications, hydrogen (production, storage and distribution) and activities to support market introduction. This also implies a re-focussing of the budget. However, even with a re-focussing of the budget, it will not be fully possible to carry out the new programme of activities with a budget similar to that of the existing FCH JU. In particular, widening the scope of the JU's activities to include energy storage in a meaningful way requires an additional EU contribution of at least 15M€/yr. An further allocation of 50M€ over the period 2014-2020 to cross-cutting issues and support actions in order to address the entire innovation value chain would seem appropriate to achieve the objectives of the JU.

125. It is envisaged that the staff number and administrative expenses of the Programme Office will not change much, since the burden of handling a larger overall budget will be offset by the efficiency gains through simplification and other measures. As a result, the running cost of the modernised JU is estimated at €40 million (with a maximum EU contribution of 20 M€), supporting a staff of around 20, similar to the existing FCH JU. Thus, in relative terms, the operational cost of PO4 will be lower than that of PO1.

126. The maximum EU contribution to the activities of the existing JU for the period 2008-2013 is 470M€, composed of 450M€ (i.e. 75M€/year) for R&D and 20M€ to support the Programme Office. An increase with 15M€/year in R&D for the period 2014-2020 would amount to 630M€ (90M€/year). Including 20M€ to support the Programme Office, and 50M€ for increased support to early deployment, **the required EU contribution would amount to 700M€** (see table below).

| 127. | R&D activities | Additional activities in support of early deployment | Programme Office | Total maximum EU contribution |
|---|---|---|---|---|
| Current FCH JU (2008-2013) | 6 * 75 | - | 20 | 470 |
| New FCH JU (2014-2020 | 7 * 90 | 50 | 20 | 700 |

Table 4. Breakdown of the maximum EU contribution to the existing and new FCH JU (M€).

128. The above EU contribution will not only benefit the members of the FCH JU. The budget allocated to R&D and activities in support of early deployment will be used through fully open Calls for Proposals and Calls for Tender. It is noteworthy that many beneficiaries (60%) of the current FCH JU are not members.

129. The proposed EU contribution to the FCH JU is based on the Commission proposal for the budget of Horizon 2020. Since the FCH JU is a priority of the Energy Theme, the proposed EU contribution remains unchanged even if the overall budget for Horizon 2020 would fall short of the Commission's proposal by up to 15%. However, should this budget be reduced even further, the EU contribution to the FCH JU could be reduced to between 630-700M€, with an across-the-board reduction in all activities.

130. In case the EU contribution would be reduced to below 630M€, the FCH JU activities would have to be refocused taking into account the technology development layout proposed in the Industry Grouping's Financial and Technology Outlook 2014-2020 (see Annex 12).

131. The private funding in the FCH JU will be both inside and outside the calls for proposals:

- The Industry and Research Groupings agreed to reduce the maximum funding rates for all beneficiaries, thus increasing their co-funding of the programme. This reduction could mainly apply to demonstration and close-to-market actions/projects. The foreseen split between research and demonstration activities is close to 50/50.

- Discussions are on-going with the Industry Grouping to precise in detail their commitments outside calls for proposals. The private contributions have to be robust and measureable. The funded activities will support the achievement of the objectives of the FCH JU.

132. The modernised JU complies with the three guiding principles governing funding models and private contributions in Horizon 2020:

- EU contribution will be allocated on the basis of transparent, open competition and excellence;

- Participation in FCH JU activities will follow essentially H2020 funding rules;

- Industry is to make commitments that are measurable, verifiable and can be valued.

133. The private sector is convinced that the FCH JU will play a major role as a catalyst for growth and declared its readiness to invest in total around 4 B€ in the period 2014-2020.

# 7. EVALUATION AND MONITORING

## 7.1. Mid-term and final evaluations

134. The Commission will carry out both the final and the mid-term evaluations of the FCH JU with the assistance of independent experts. It will cover the quality and efficiency of the Joint Undertaking and its progress towards its objectives. The Commission will communicate the conclusions of the evaluation to the Council and the European Parliament.

135. The general objectives will be monitored continuously by the Industry grouping, using performance indicators such as market share and number of new jobs created.

## 7.2. Monitoring the FCH technology progress

136. A set of Key Performance Indicators (KPIs) is proposed to monitor the FCH JU during the period 2014-2020, in line with the specific objectives of the Programme

(as described in Chapter 3). The proposed KPIs are also consistent with the current Multi-Annual Implementation Plan (MAIP) of the FCH JU.

| Area | Description | 2012 Current status | 2016 Target | 2020 Target |
|---|---|---|---|---|
| **Transport** | **Specific Objective 1** | | | |
| | Automotive fuel cell system cost [€/kW] | >500 | 100 | 50 |
| | Automotive fuel cell system lifetime [h] | 2,500 | 4,000 | 5,000 |
| | Bus fuel cell system cost (€/kW) | >3,500 | <2,000 | <400 |
| | Bus fuel cell system lifetime (hrs) | 6,000 | 9,000 | 12,000 |
| **Energy** | **Specific objective 2** | | | |
| | Industrial/commercial power, H2 based, cost (€/kW) | 4,500 | 3,000 | 1,500 |
| | Industrial/commercial power production fuel cell system, H2 based, efficiency (%) | 45 | 50 | 55 |
| | Industrial/commercial power production fuel cell system, H2 based, durability (hrs) | 8,000 | 20,000 | 40,000 |
| **Hydrogen** | **Specific Objective 3** | | | |
| | Distributed H2 production, electrolysis, capex (M€/t/d) | 8 | 4 | 2 |
| | Distributed H2 production, electrolysis, efficiency (%) | 67 | 72 | 77 |
| | **Specific Objective 4** | | | |
| | Capacity of storage of energy through hydrogen | - | 10 MWE | 100 MWe |

## 7.3. Monitoring the operations of the Joint Undertaking

137. The operations of the JU will be closely monitored at different levels. An internal monitoring will result in an Annual Activity Report.. The annual Stakeholders Forum will contribute to the exchange of information - and to help coordinating activities between - the JU, other EC initiatives, and national and regional and private actors. The annual Programme Review will allow an assessment of the progress of the FCH-funded projects and will report on the progress of the FCH technology in Europe. The following KPIs are proposed to monitor the operations of the JU:

| Area | KPI description | Target | When? |
|---|---|---|---|
| **Operational objective 1** | Private and public expenditures in R&D, innovation and early deployment activities in Europe (triggered by JU) | > €1,4 billion over 2014-2020 | By 2020 |
| **Operational objective 2** | SME participation in the JU programme | ≥25% | Every CfP |
| **Operational objective 3** | FCH JU demonstration projects hosted in Member States and Regions benefitting from EU Structural Funds | 7 projects | By 2020 |
| **Operational objective 4** | Time to grant (from call closing to grant signature)<br>Time to pay | < 180 days<br>< 90 days | Every CfP |

## Annex 1 - Group of Independent Experts advising on the Impact Assessment

An independent expert panel was appointed to contribute to this Impact Assessment and was composed of three members chosen from different areas of expertise in fuel cell and hydrogen technologies. Consideration was also given to geographic balance in the membership of the panel. The experts have provided a valuable contribution in describing the current situation of the fuel cell and hydrogen sector in Europe, defining the possible options for the future implementation of research activities in this field and assessing and comparing the potential impacts of these options. They have worked independently under the coordination of the Commission. The members of the panel were:

1. Nigel Lucas has more than 30 years' experience in the energy sector and is a reference in the field of fuel cell and hydrogen in Europe. He also has a sound socio-economic and environment background. He is very familiar with the European Commission processes. In 2007, he played a leading role in the preparation the Impact Assessment of the first FCH JU, and has since chaired evaluation panels of the JU.
2. Pierre Millet has more than 20 years' experience in the energy sector, including fuel cell and hydrogen technology. As an academic he has participated in several evaluations of calls for proposals - with the FCH JU but also for several energy themes.
3. Manfred Horvat has more than 30 years' experience in technology development and policy, including in the energy sector. He has a sound socio-economic and environment background, and is knowledgeable on European research and innovation. He is familiar with the fuel cell and hydrogen sector and has participated in previous impact assessments as well as in the interim evaluation of the FCH JU in 2010-2011.

## Annex 2 - Results of the stakeholder survey

**Introduction**

The Fuel Cells and Hydrogen Joint Undertaking (FCH JU) commissioned this report to a consultancy to get a better understanding of the past and future evolution of the European Fuel Cell and Hydrogen (FC&H) sector, and the role that public support has in that evolution.

The results of this report are based on three data sources:

- **Survey results**: A survey was sent out to 458 companies that are liaised to the FCH JU. 154 people responded. (see list in annex).
- **Desk research**: A wide range of industry reports was consulted to supplement and cross check the results of the survey. However, given the still nascent state of the industry, the information gathered with this exercise was limited.
- **Interviews**: Key stakeholders in the European FC&H sector were interviewed to get the qualitative story behind the results from the survey and the desk research. These stakeholders varied from fuel cell manufacturers to government officials, from energy companies to automotive OEMs.

1. Substantial growth in recent years

Europe has set itself a goal to reduce CO2 emission levels by 2050 to 80% of what they were in 1990. To reach this target, Europe will have to change both its energy supply and demand side. Fuel cells and hydrogen have potential to contribute to overcoming the energy challenges that accompany this change.

- **Mobility**: Worldwide, mobility applications have made up the largest share of fuel cell production in recent years. Hydrogen fuel cells in passenger cars and public transport reduce local emissions without compromising range. The cost trajectory of fuel cells vehicles (FCEVs) shows they will get closer to the cost- competitive range of incumbent and new technologies within the next decade. Niche applications, like forklifts, are already available on a commercial scale. Pilots and pre-commercialization projects are increasing in size and commitment. The most prominent example is H2 Mobility (H2M), the German hydrogen coalition of car manufacturers, energy companies and fuel providers who are jointly developing a business and implementation plan for a hydrogen refueling infrastructure that allows for fuel cell vehicles to go to market. In other European markets, such as the UK, France, the Netherlands, Denmark and Norway, similar coalition efforts are being undertaken or launched.
- **Power and heat**: Stationary fuel cells offer highly efficient and reliable combined heat and power (CHP). The market can be roughly segmented into:
  - Residential CHP (1 kW systems)
  - Backup and off-grid solutions (3-20 kW)
  - Commercial scale (50 kW and up)

Fuel cells are gaining market share especially in the middle segment, where they are competitive with the incumbent technologies (e.g., gas and diesel gensets) despite high technology costs.

- **Energy storage**: Hydrogen energy storage solutions have grown in importance given the intermittency issues that arise with increasing penetration of renewable energies (RES). This fact is further underlined by the many opportunities that have been created over the past years for hydrogen storage demonstrations: Vattenfall and Total have built a hydrogen storage project of EUR 21 million in Prenzlau, and the Eco Island of Wight (with IBM, ITM Power and others) has attracted over EUR 300 million of investment, part of which is used for hydrogen storage.

The FC&H sector in Europe has done well over the past five years: Survey respondents report that, on average, annual turnover has increased by 10% (on a 2012 total of EUR 0.5 billion), R&D expenditures by 8% (on a 2012 total of EUR 1.8 billion) and market deployment expenditures by 6% (on a 2012 total of EUR 0.6 billon).

This has led to increase in employment. Survey respondents estimate the total number of jobs has been increasing by about 6% per year since 2007, to around 4,000 FTE today. Even though this number excludes companies that have ceased to exist, the overall trend is significantly better than that of the average EU job market, which, over the same period, has actually contracted, registering a 0.3% annual reduction in employment.

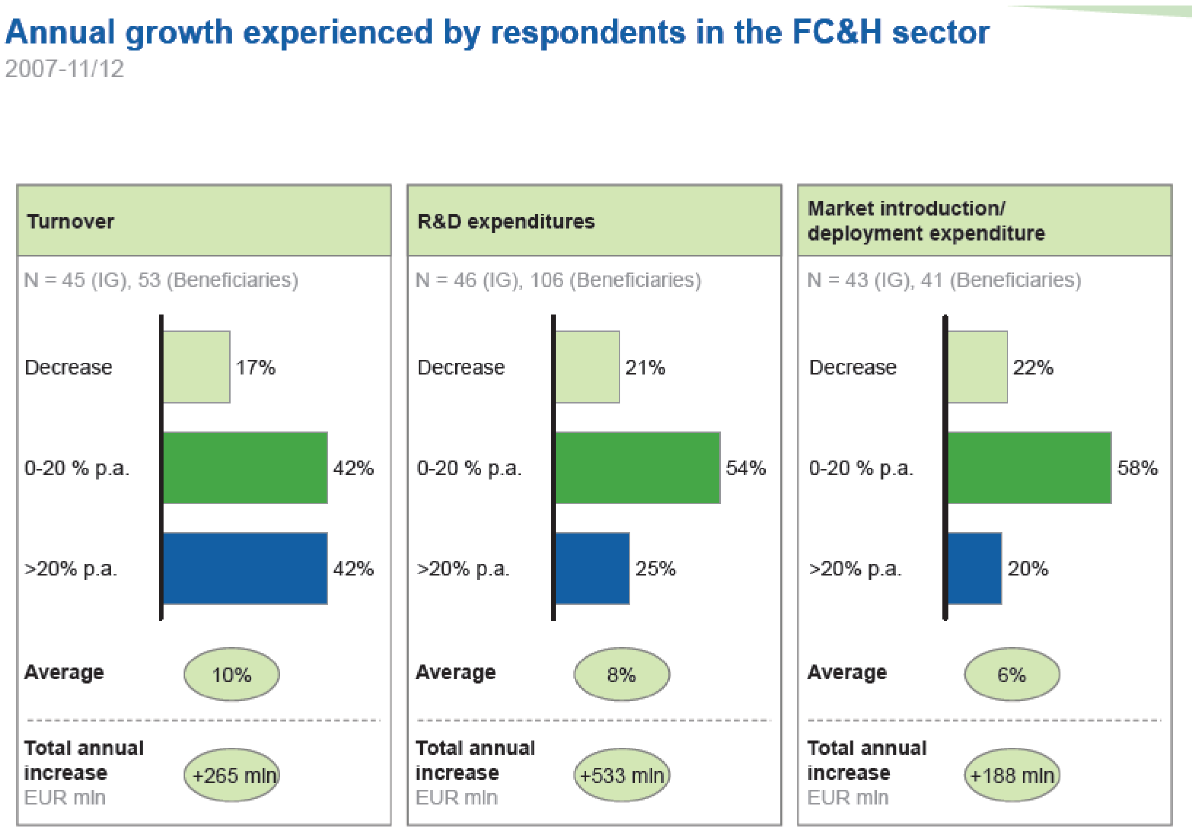



*Exhibit 1*

In the number of patents granted, the FC&H sector also outpaced the rest of the industry: it saw a 16% annual increase in the number of patents granted in the EU to European companies, while the average annual growth for all EU industries was 1.5%. However, in the US and Asia the growth in FC&H patents outpaced that of Europe.

The rise in employment, turnover, expenditures and R&D activity is strengthened by combined public and private funding to improve hydrogen and fuel cells.

Exhibit 2 shows that private funding has been steadily rising in Europe, while public has remained constant (EU) or even declining (national budgets). Private funding is and has been the biggest contributor to R&D spend, totalling more than an estimated EUR 2.5 billion over the period 2005-2010. This figure roughly corresponds with the estimation that was made at the beginning of the period (corresponding to the launch of FP7 and preparation of the FCH JU) , the private sector has lived up to its original investment promise.

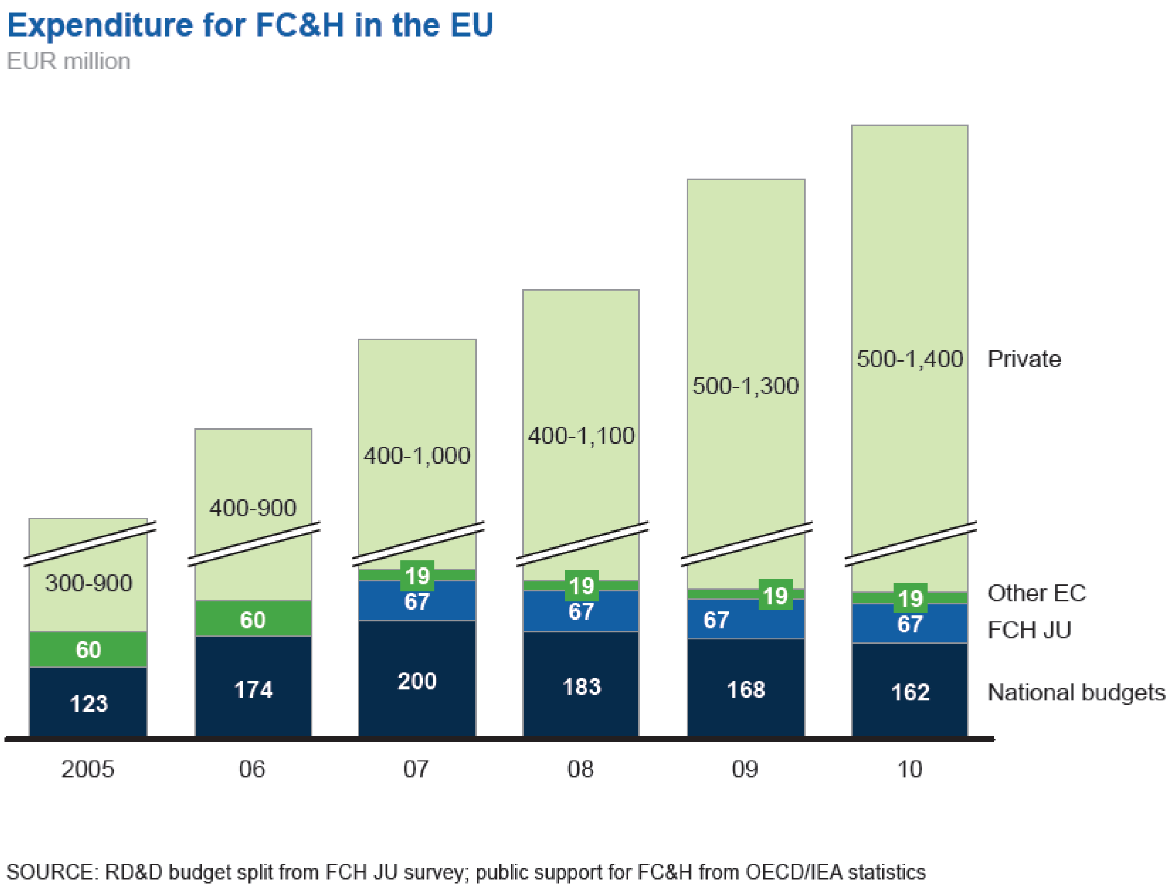



*Exhibit 2*

Survey respondents claim that national programs (estimated at EUR 1 billion from 2005¬2010) and EU programs (estimated at almost EUR 0.5 billion from 2005-2010) play a pivotal role in enabling private investment, though: larger companies depend on a stable investment, policy and "direction" climate to secure their funding levels. In addition it is mentioned that, small R&D companies - responsible for researching and realizing cost reductions in the sector -still depend on public funding from both national and European programs.

Many of the interviewees conclude that the combined effort of public and private funding has worked very well over the past years.

The FC&H sector is building momentum in and outside the EU. In the US, forklift trucks are being commercialized, and Japan leads commercialization of micro CHP. Europe could soon follow the same trend. This is recognized by the survey participants, who expect all FC&H applications to become commercial by 2020 (see exhibit 3).

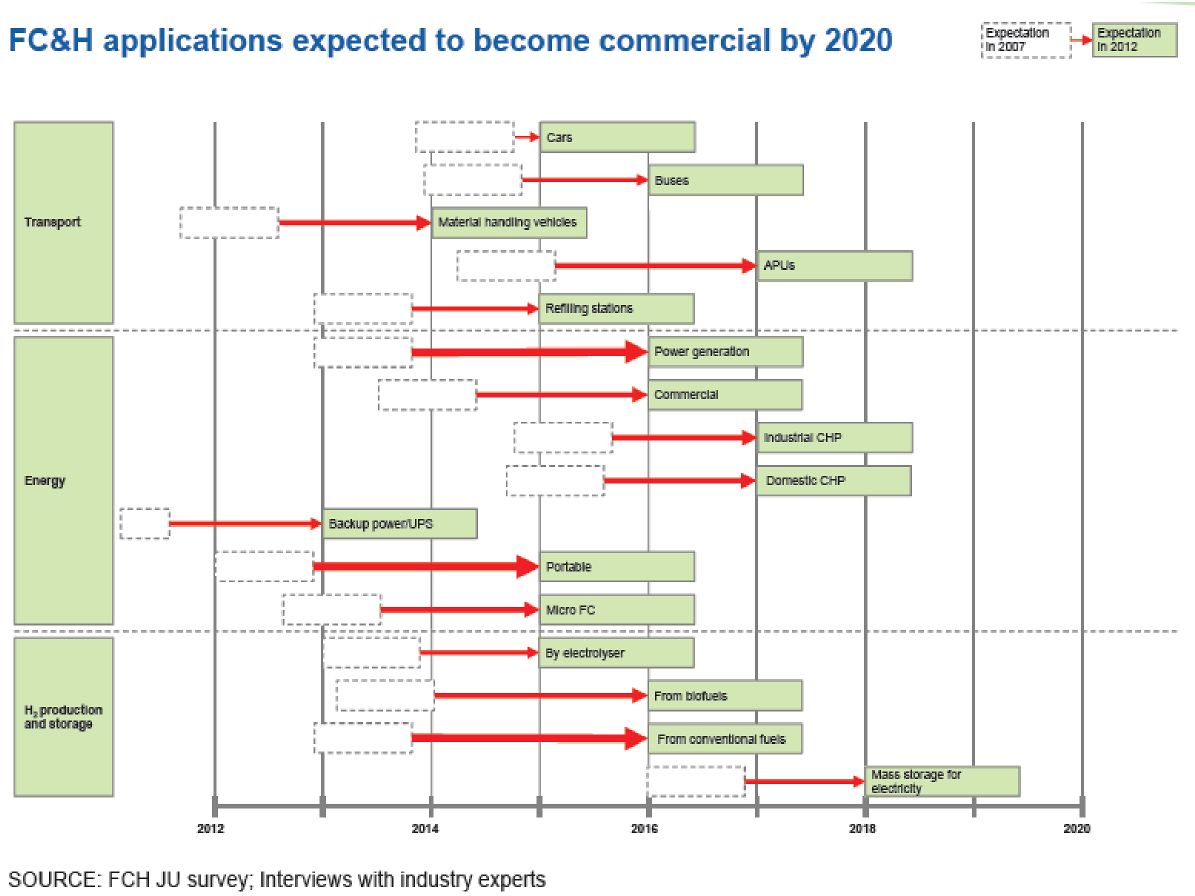



*Exhibit 3*

2. Industry is expected to continue to thrive

In most application areas, commercialization has been slower than industry experts had anticipated in 2007. Car manufacturers are the exception: they have been very consistent, estimating commercialization by 2015. These expectations of car manufacturers are further underlined by promising statements from Asian and European car manufacturers.

In other application areas, many interviewees mention the increased focus on energy storage through electrolysis: Although delayed in commercialization by about a year, recent developments in renewables roll-out have imposed new dynamics on transmission & distribution grids, but also on peak versus base power pricing - storage solutions like hydrogen are regarded by many as a potential mitigation and business opportunity in this space.

Although delayed in commercialization by about a year, recent developments in renewables roll-out have imposed new dynamics on transmission & distribution grids, but also on peak versus base power pricing - storage solutions like hydrogen are regarded by many as a potential mitigation and business opportunity in this space.

When asked for their expectation on turnover and Research, Development & Demonstration (RD&D), the respondents predict an exponential increase towards the end of the decade (see exhibit 4).

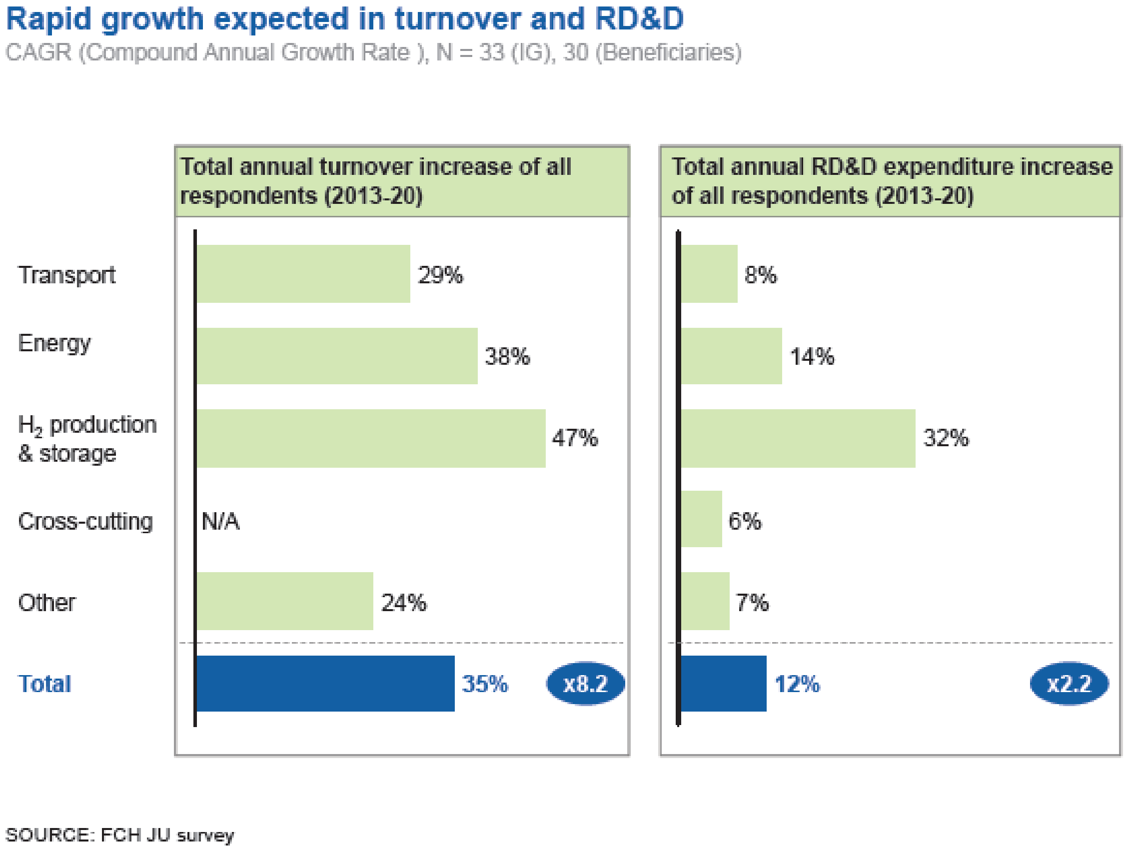



*Exhibit 4*

On average, they expect turnover to increase by 35% year on year towards 2020 (i.e., the turnover for the period 2013-2012 should be eight times higher than during the current period corresponding to the FP7 and the current FCH JU). At the same time the RD&D is expected to increase by 12% year on year - or a doubling over the period 2013-2020.

The fact that turnover is outpacing RD&D expenditures is an indication that commercialization is within sight. This is supported by the perspectives of the interviewees (see exhibit 5).

Survey participants expect their future activity to be evenly spread across Transport, Energy, and H2 production & storage. The most progress is expected in hydrogen mobility and in energy storage.

- **Mobility**: Car manufacturers expect to FCEVs in Germany by 2020, thanks to the H2M coalition effort. Similar projects are being undertaken in the UK and Denmark and expected to start in France and the Netherlands.

- **Energy storage**: Groups of utilities and electrolysis companies are partnering up to develop energy storage solutions for intermittent RES power generation. The scale of these programs is moving beyond "demo scale".

- **Industry**: Projects to deliver CO2 free hydrogen to industry are being examined . Recently, a group of companies studied a demonstration opportunity in Rotterdam to build a gas based hydrogen production facility (Steam Methane Reformer, SMR), combined with offshore storage of CO2. In doing so, it would create a CO2 abatement option for heavy industries.

- **Power**: Although not as thriving as the micro CHP programs in Japan (ENE Farm), fuel cell manufacturers are starting to commercialize fuel cells in small - but still significant - market segments. German programs, for instance the Callux program, and the ENEFIELD project (deploying 900 domestic CHP units in the coming years) prove helpful in this. Commercialization options include backup- and off-grid solutions, but also industrial sites with excess hydrogen.

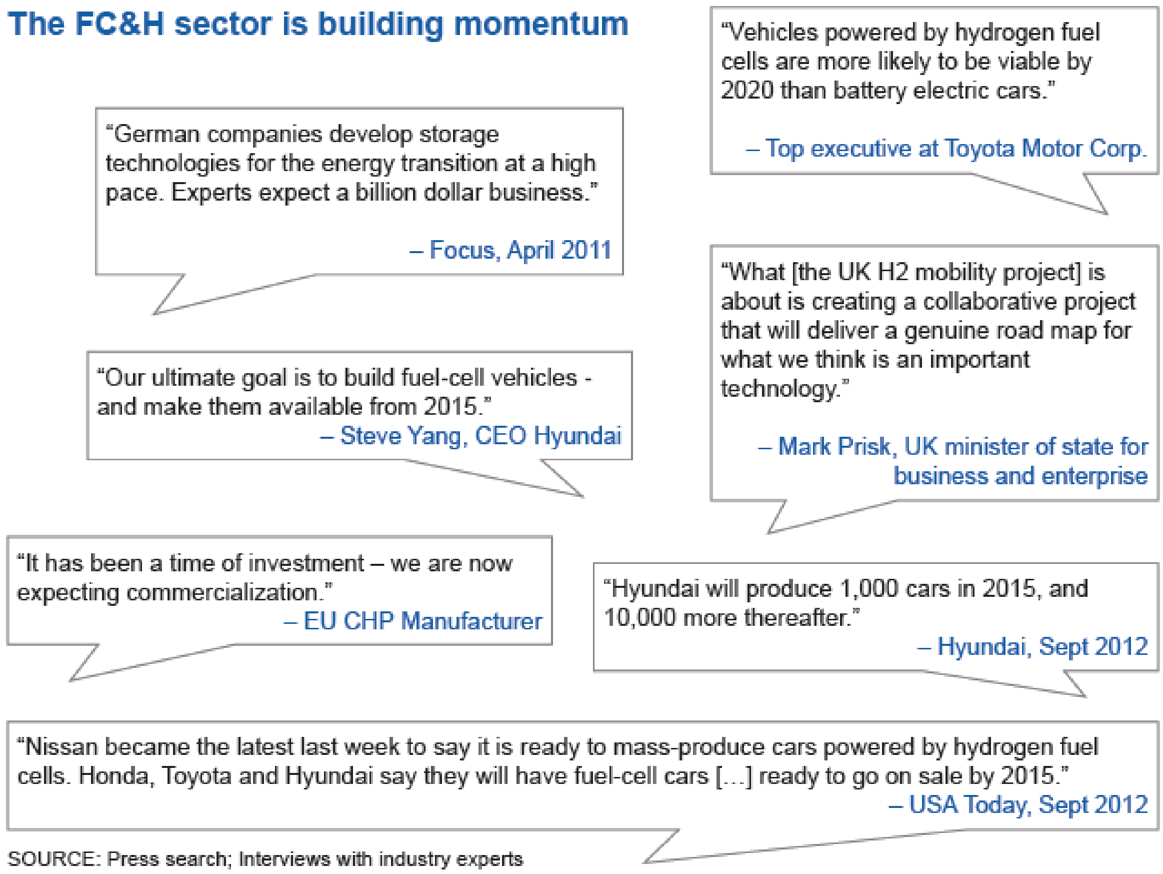



*Exhibit 5*

As a result of this progress, companies expect employment to increase even more sharply than in recent years: respondents expect 9% growth per annum, amounting to a doubling of the jobs over the period 2013-2020. In addition, the average number of people per respondent organization is growing faster (from 28 to 67), which might indicate a concentrating effect in a sector currently composed of small firms (see exhibit 6).

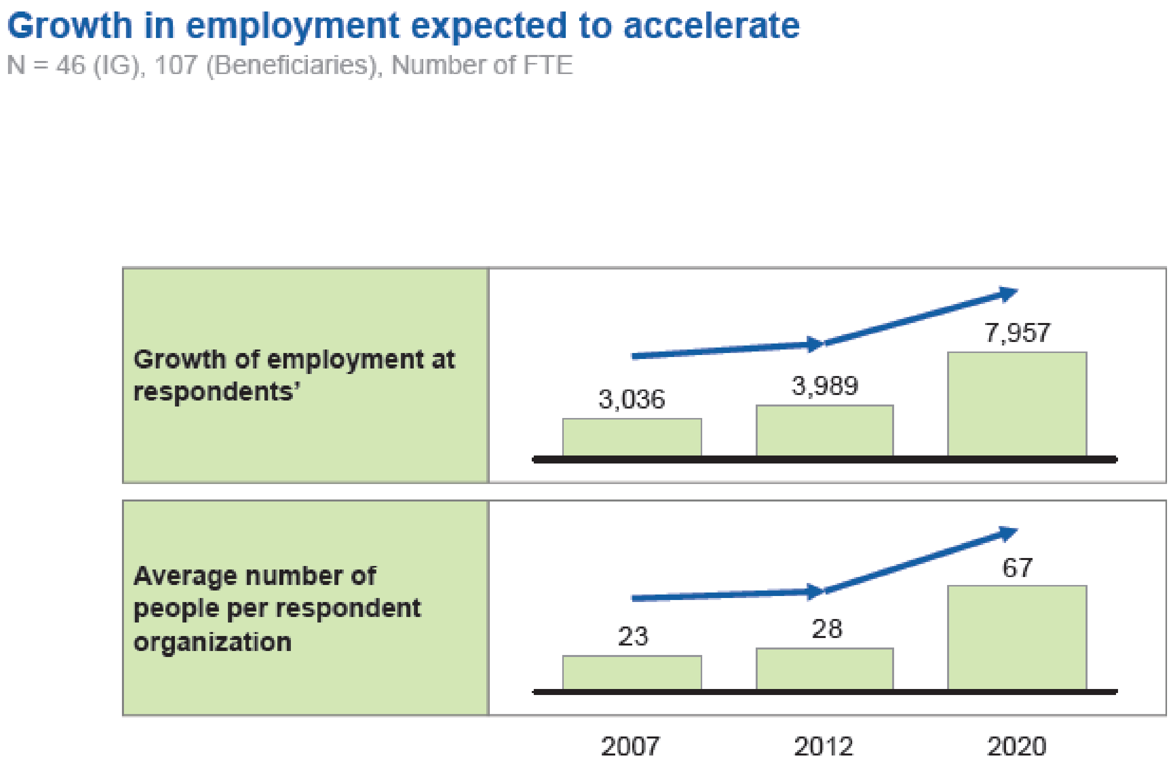



*Exhibit 6*

3. Critical challenges to overcome

The outlook set forward in the previous section is not guaranteed. Key stakeholders indicate in their interviews that there are five critical challenges that need to be overcome in order to be successful: the commercialization rate, infrastructure, the continuation and maturity of research, competition with other regions and technologies, and public acceptance.

**Commercialization rate**: The expected date of commercialization has systematically fallen behind promises. Although the influence of the financial crisis and "usual setbacks" should not be neglected, many interviewees do worry that the time is "now or never". As one interviewee said: "Fuel cells and hydrogen have been said to commercialize within the next 10 years ... since 1954". Missing a credible and accurate time path is also a risk in attracting and retaining investors. Some interviewees indicate that large companies with a widespread portfolio of R&D activities might deprioritize or abandon FC&H if the industry does not mature in line with expectations.

**Infrastructure**: In the mobility segment, fuel cell vehicles depend fully on a widespread fuelling infrastructure to attract customers. This poses the well-known "chicken and egg" problem: energy and fuel companies will invest only if there is a sizeable market of FCEV owners, and car manufacturers will produce FCEVs at scale only if the necessary infrastructure is present. Although these problems can be solved by cohesive, coalition-led activities, this is by no means an easy route. The German H2 Mobility is advanced in getting a joint suite of investments in place - but it is still too early to claim success for that effort, mention some interviewees.

**Research**: Beneficiaries and respondents mention that Research and Development is vital for commercialization, and especially domestic and commercial CHP. The majority of this research along various parts of the supply chain is done by small companies. These companies depend on national and European funds and grants to finance their activities. The financial crisis might put this support for sustainable FC&H technology at risk. Respondents also mention that the research focus and quality of these companies do not always correspond with the priorities of companies further down in the value chain, and this limits the impact of the R&D done.

**Competition from other regions and technologies**: Thus far, interviewees say that the US and Asia have been more successful in bringing FC&H products to market. Forklifts applications are introduced in the US, while Japan has a successful ENE Farm project. The challenge of competition is also illustrated by the shipment of technology in sectors where Europe is lagging (see exhibit 7) and by comparing national investment levels and patent applications (see exhibit 8). Although the majority of mobility related hydrogen activities occurs in Europe, many say the European industry sector should be careful that the nucleus of knowledge development does not permanently shift out of Europe. "This could put the current and expected employment opportunities at risk and jeopardize Europe's competitive advantage in sustainable technologies".

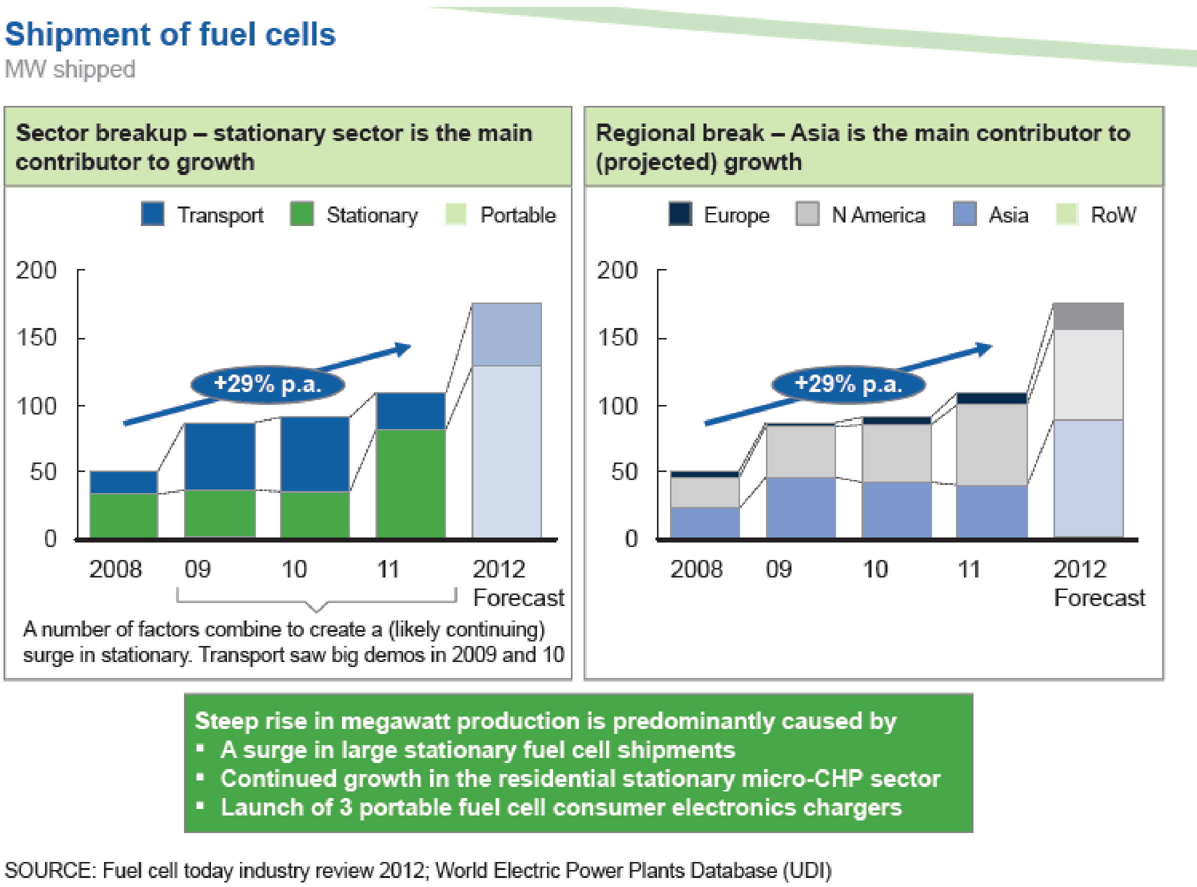
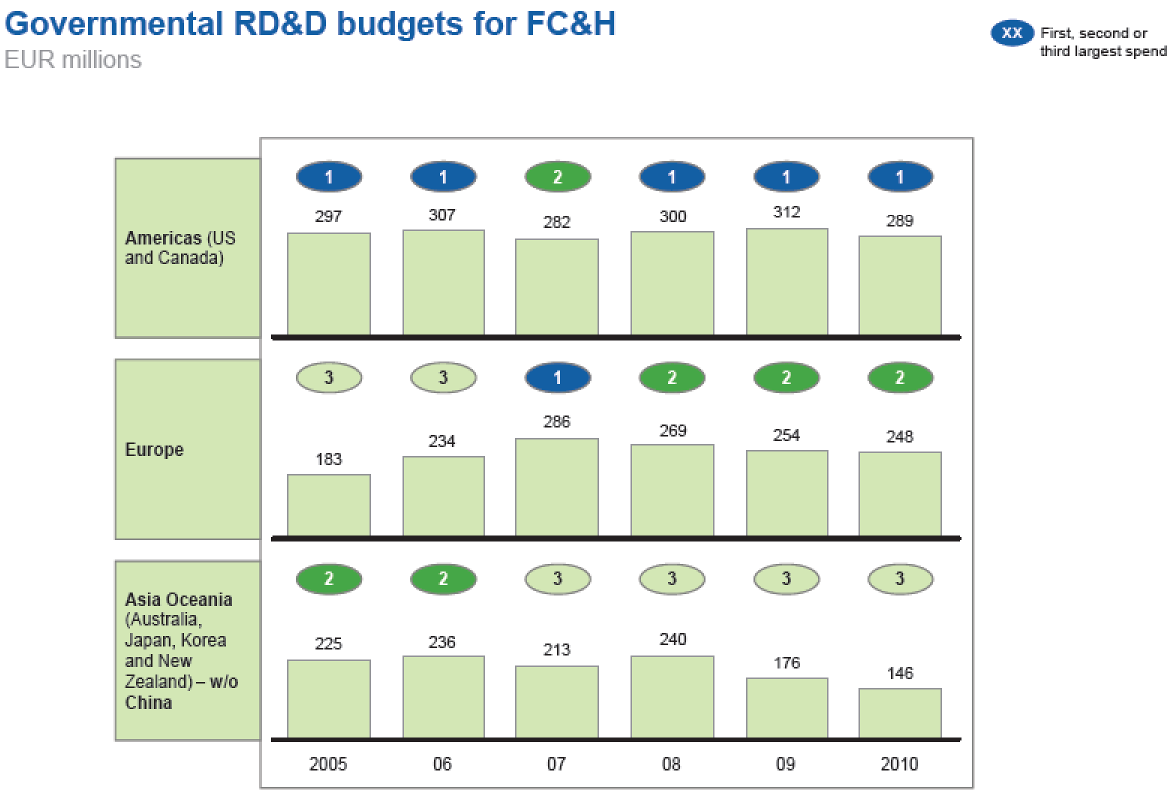


*Exhibit 7*




SOURCE: OECD/IEA statistics; Fuel cell today industry review 2012; Interviews with FC&H industry players

*Exhibit 8*

**Public acceptance**: The press coverage for FC&H technologies is limited to the perspective provided by industry players - and to this date, have not received wide-spread public attention. Although the arguments put forward progressively indicate a preference of fuel cells, as for instance stated recently by Toyota officials, the opinion makers are not yet pronounced in their stance towards hydrogen. Once commercialization is nigh, public awareness and acceptance will need to be very carefully managed. Recent activities like the EU Hydrogen Roadshow are good examples of how to manage this awareness and acceptance

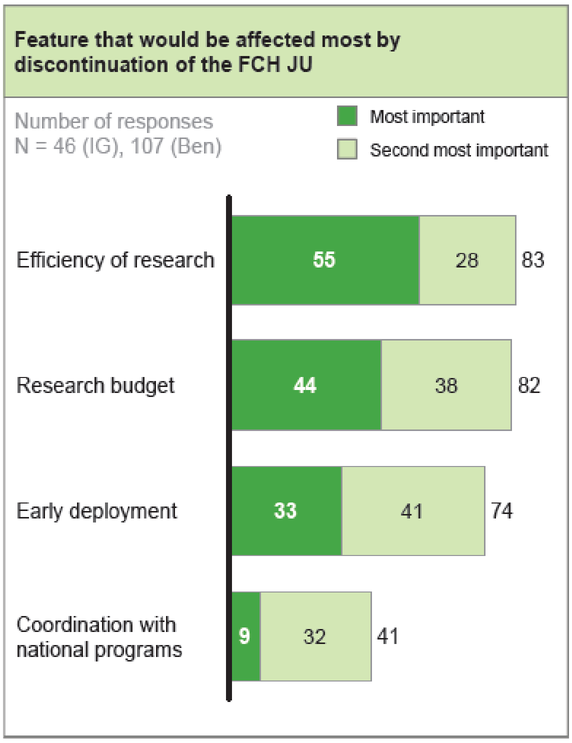
4. Public support required in the coming years

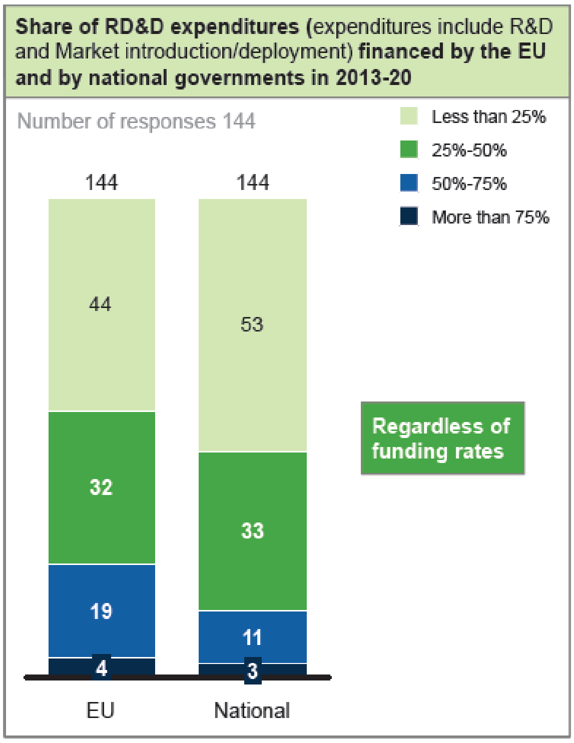
Interview and survey participants say the EU should keep investing in fuel cells and hydrogen production development in 2013 -20 to overcome the challenges of deployment. They also mention it should continue to co-fund R&D to drive down costs and enhance performance of products (see exhibit 9).

Out of 153 survey participants, 55 indicated that efficiency of research would be most affected in case the FCH JU would be discontinued, and 44 indicated that the research budget itself would be most impacted.

The latter is further illustrated by the fact that 56% of the respondents depend on EU financing of their RD&D expenditures for at least 25% or more. It proves to show that EU needs to continue to co-fund R&D to drive down costs and enhance performance of products.

## The need for public funding




SOURCE: FCH JU survey; Interviews with FC&H industry players

*Exhibit 9*

Interviewees add that maintaining a consistent investment policy is crucial to ensure the survival of the nascent FC&H industry: demand of fuel cell technology will only pick up when the supply side has matured sufficiently and vice versa. They mention it is too early for the industry to reach sufficient maturity on private sector investments alone. Furthermore, Europe should keep up with the rest of the world in investments in R&D. These investments could sustain the leading position Europe currently has in mobility. Public opinion is required to change from fear for safety to vocal support for carbon-neutral FC&H technology. The industry needs a consistent and facilitating policy to make the FC&H industry into a success.

5. Way forward for European support

Survey participants indicate that the FCH JU has sparked investments across the FC&H industry, resulting in significant leverage: almost 60% out of 150 organisations asked have increased their R&D expenditures/budgets because of the FCH JU's existence (exhibit 10).

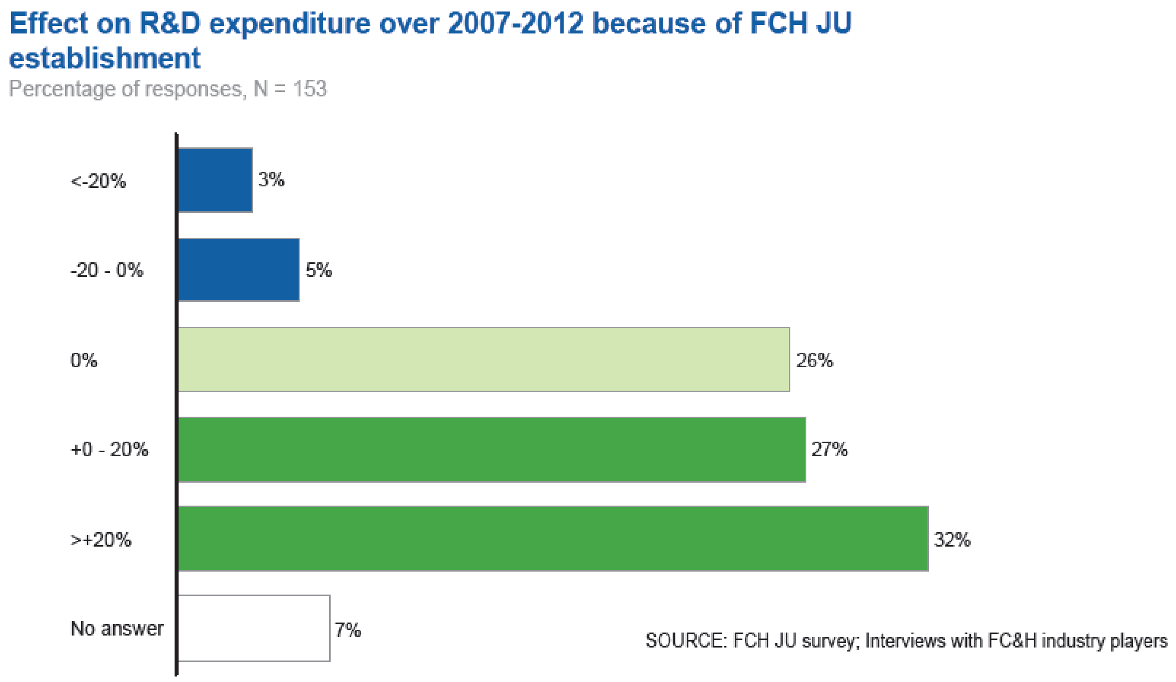



*Exhibit 10*

In addition, interviewees and survey respondents acknowledged the achievements of the FCH JU in the past years:

**Providing stability and long-term commitment to the industry**: The FCH JU has united the various stakeholders in the European FC&H community. Due to the support it receives from a collective of public and private stakeholders, the individuals inside and outside the FCH JU find stability in this collective. The existence and longer term outlook provide a stable environment and, as one interviewee said, "Without the FCH JU being there, our company would have exited hydrogen in dire economic times."

**Leading as one voice to address policy makers**: The collective of stakeholders has a single voice towards regulators in the EU via the FCH JU. Many interviewees applaud the connections that the FCH JU has fostered, and the inroads that have been made - especially when compared to similar other industry bodies they are involved in.

**Building coalitions as a central focal point that brings parties together**: Interviewees mention as a clear example of this the recent Bus study - the FCH JU took the initiative and led the effort of comparing the various bus drivetrains. In situations where individual companies cannot or will not be the frontrunner in taking initiative, the FCH JU can.

**Supporting nascent technologies beyond local or private possibilities**: The FCH JU has funded a broad range of research projects in the FC&H space. Without these funds, it is said by interviewees, many technology breakthroughs would not have occurred, nor would some of the smaller companies involved in this research have been able to thrive.

Interviewees and survey respondents also suggested some improvements for the FCH JU to maintain its momentum:

**Focusing on an overarching strategy to increase effectiveness**. Most interviewees see an ever larger role for the FCH JU in actively shaping the R&D agenda for FC&H. Some suggest that investments are at times too piecemeal, not assessed on "bang for the buck", and following a logic of spreading the funding evenly across FCH JU participants, instead of awarding more funding to a smaller number of players. Interviewees suggest that the FCH JU shapes an agenda of topics that are deemed most critical, within and across sectors/applications, and assigns funding accordingly based on "return on investment". This also requires the FCH JU to take a stance on what they believe to be true priority areas in technology development.

**Ensuring a first "big success", which can be celebrated and promoted**. The long and often slipping timeline of commercialization has led stakeholders of various sizes to a point where they will need to convince their internal and external stakeholders that FC&H truly is near commercialization. Many interviewees therefore ask the FCH JU to ensure a large success, which can be celebrated across the sectors and used to demonstrate the viability of a number of applications. The German H2M project is often mentioned in this context: successfully bringing this to a close is regarded as pivotal for the survival of the entire sector: "If even large companies cannot find a way to make this work, this clearly is not a sector with a bright future".

**Improving execution speed and lowering complexity for the grant award process**. Some of the respondents mentioned that, although the process of securing project funding through the FCH JU has significantly improved over the past years, it is still too slow. If research priorities are more clear and broadly shared (as proposed in the first improvement point listed above), it would reduce the complexity and assessment time of proposals.

# Annex 3 - Results of the public consultation

## Background information and methodology

The on-line questionnaire for a public consultation concerning a Public-Private Partnership (PPP) in Fuel Cell and Hydrogen under Horizon 2020 (the next framework programme for the period 2014-2020) was launched on 11 July 2012 and was closed on 4 October 2012. It was available at the following website:

http://ec.europa.eu/research/consultations/fch_h2020/consultation_en.htm

All citizens and organisations were invited to submit their views and opinions. Contributions have particularly been sought from companies, including SMEs, and research organisations active in research and innovation on FCH technologies. In addition to being published on the 'Your voice in Europe' website, the information about the public consultation was widely disseminated by highlighting the initiative at a series of dedicated stakeholder meetings that took place during the summer 2012, publishing it on the FCH JU website, informing the members of the advisory groups of the FCH JU (States Representatives Group and Scientific Committee), contacting project participants and sending information to a large list of stakeholders.

The consultation aimed at gathering key views relating to the possible extension of the FCH JU under Horizon 2020. For this purpose, a comprehensive set of questions was drawn up to identify the current key challenges in FCH research and innovation, the added value and potential impact of addressing these challenges via a PPP Joint Undertaking (JU) under Horizon 2020. The consultation also included questions addressing possible legal structures based on the options available under Horizon 2020 and recommendations from a high-level expert group. Respondents were moreover queried about lessons learned from the 1$^{st}$ FCH JU.

In total 127 respondents answered the questions. The participants were given the possibility to add further comments at the end of their contribution, and also to upload any position paper or document relevant for the consultation. 17 position papers were uploaded as well as 39 "further comments". The analysis of the data is presented in this document, together with a summary of the papers and the list of comments. Some participants chose to remain anonymous, and three requested their contribution not to be made public.

## Key messages

The consultation responses can be summarised as follows:

- Respondents know about the FCH JU, since 57 declared to be very familiar and 49 to be familiar with the organisation. These answers combined represent 83.5% of all answers. Almost 50% of respondents had applied for FCH JU funding, and 42% were actually funded.

- Most respondents agree on the fact that FCH technology will play a notable role in the future EU low-carbon energy and transport sectors (98% of respondents), for the EU energy security of supply (94%) and for the EU industrial competitiveness (95%).

- Most also agree that the currently targeted applications can have an important socio-economic impact by 2020, with a particularly strong support for the use of hydrogen as storage medium for renewable energy (95% of respondents).

- Most respondents also believe that both the European FCH industry and the FCH research sector are more competitive or stronger than 5 years ago, and that they have the potential to be even more competitive by 2020 (99% for industry, 95% for research).

- 87% of the respondents believe that the industry cannot address the problems alone and 67% agree that Member States support will not suffice. An overwhelming 96% think that an intervention at EU level is required.

- Regarding the main problems faced by Europe, the lack of support of decision makers (87%), of access to risk finance for deployment activities (82%) and of public awareness (75%) are the main problems to be addressed in Europe. The lack of competitiveness of the technology comes last in this question (only 37% of respondents agree with this aspect).

- The lack of public RD&D funding is by far the most quoted underlying problem (81%). Research infrastructure does not seem to be a problem (38%).Other possible underlying problems range from approx. 55% to 65% of agreement.

- Regarding the current FCH JU, the majority of the respondents think that the FCH JU has reach most of the EU objectives. In order of importance, they believe this mechanism has provided medium-term stability on research, development and demonstration (RD&D) public funding for the FCH sector (79% of respondents), has contributed to increase European competitiveness (76%), has increased and improved coordination between stakeholders at EU level (72%) and has increased the involvement of the industry in RD&D on FCH (71%). Many other aspects score above the 50%. For EU-12 involvement, outreach, and simplification of access to funding, the score is below 50%.

- Regarding future priorities, the 2 most quoted areas are hydrogen as a storage medium for renewable energy (80% of support) and refuelling stations for transport applications (75%).

- 65% of the respondents support the recommendation of the Sherpa group, i.e that it should be possible for JUs to support, to a certain extent, activities which do not directly qualify as RD&D, provided they contribute to the achievement of their innovation ecosystem goals.

- The continuation of the JU - in its current format or "modernised" - is the favoured option (70% calling for a continuation, incl. 53% in a modernised version), while a contractual Public-Private Partnership is only favoured by 4%.

- Most respondents believe that the FCH JU will have an impact on the EU competitiveness (77% of positive feedback at short-term, 88% at medium-term and 84% at long-term).

**Response to the public consultation**

Respondent profile

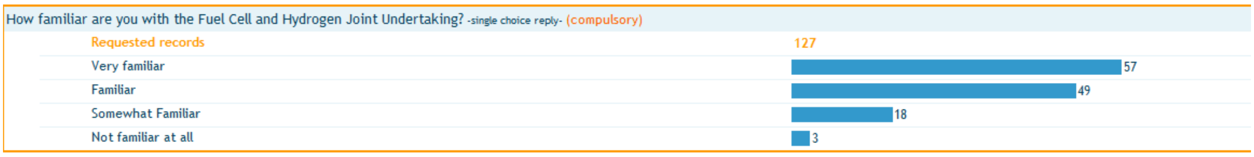
Respondents originate from at least 22 different countries, including 5 from associated countries. France is the most represented (30% of respondents), followed by Germany and the UK (approx. 13% each). The participation of Nordic countries and EU-12 countries is low.

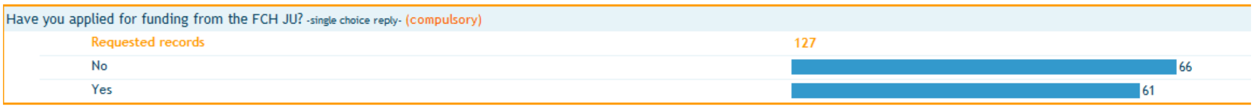
| Please indicate your current country of residence or where your organisation is based. -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| France | 38 |
| Germany | 17 |
| United Kingdom | 16 |
| Belgium | 10 |
| Spain | 7 |
| Italy | 6 |
| Associated country | 5 |
| Greece | 4 |
| Netherlands | 4 |
| Other | 3 |
| Czech Republic | 2 |
| Denmark | 2 |
| Finland | 2 |
| Slovenia | 2 |
| Sweden | 2 |
| Austria | 1 |
| Bulgaria | 1 |
| Hungary | 1 |
| Ireland | 1 |
| Poland | 1 |
| Portugal | 1 |
| Romania | 1 |
| Cyprus | 0 |
| Estonia | 0 |
| Latvia | 0 |
| Lithuania | 0 |
| Luxembourg | 0 |
| Malta | 0 |
| Slovakia | 0 |
| Candidate country | 0 |

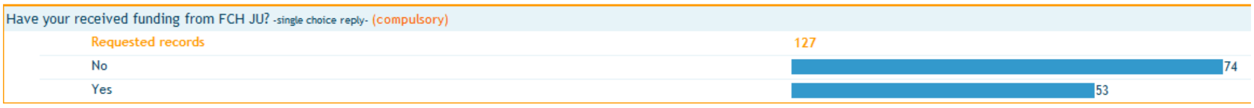
Most respondents are individual citizens (28%), followed by SMEs and research organisations (19% each). No national or regional administration has answered to the consultation. Only a few MS and decentralised authorities answered to the survey.

| Who do you represent? -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Individual citizen | 35 |
| SME (less than 250 employees) | 24 |
| Research organisation | 24 |
| Large business | 18 |
| Business organisation | 8 |
| Non-governmental organisation (NGO) | 7 |
| Other | 6 |
| Member State administration | 3 |
| Regional/local administration | 2 |

Most respondents declared that they are very familiar or familiar with the Joint Undertaking (83.5%), but the majority has never applied for funding nor got any funding from the FCH JU, which is seen as a logical consequence of the number of individual citizens that have participated in the consultation.

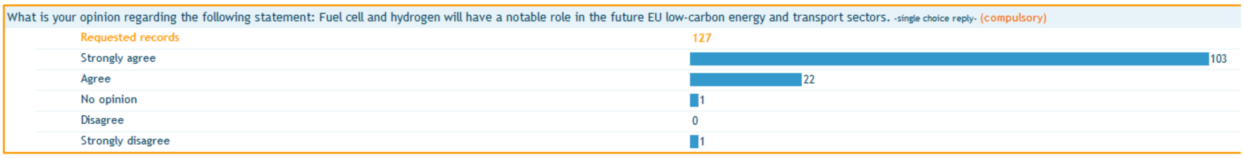


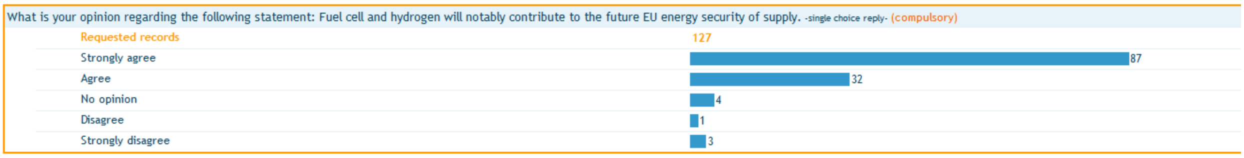



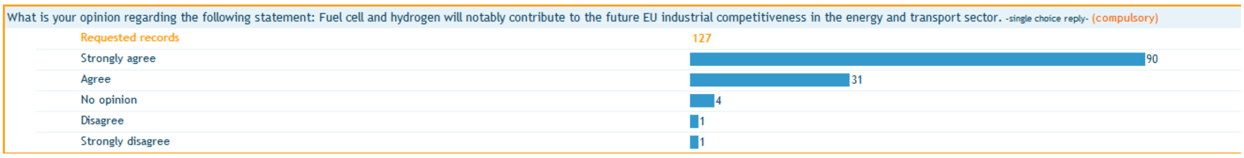




<u>Relevance of the sector</u>

An overwhelming majority of respondents believe that FCH technology will have a notable role in the future EU low-carbon energy and transport sectors (98% of respondents), for the EU energy security of supply (94% of respondents) and for the EU industrial competitiveness (95% of respondents).




The majority of respondent have a positive opinion on the potential of socio-economic impact of all of the currently targeted applications by 2020. There is a very strong support to the use of hydrogen as storage medium for renewable energy (95% of respondents). Other applications such as transport, residential or industrial CHP or back-up power score higher than 80%. Only 3 applications gather less than 80% of positive opinion (but still more than 60%): biogas reforming for hydrogen production, micro fuel cells and material handling equipment.

| Light duty vehicles (passenger cars), with refuelling stations.<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| 1- Very positive | 65 |
| 2- Positive- | 44 |
| 3- Neutral | 15 |
| 4- Negative | 2 |
| 5- Very negative | 1 |

| Heavy duty vehicles (e.g. buses), with refuelling stations<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| 1- Very positive | 71 |
| 2- Positive- | 40 |
| 3- Neutral | 14 |
| 4- Negative | 2 |
| 5- Very negative | 0 |

| Transport Auxiliary Power Unit (for trucks, ships and aircraft)<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| 1- Very positive | 50 |
| 2- Positive- | 52 |
| 3- Neutral | 23 |
| 4- Negative | 1 |
| 5- Very negative | 1 |

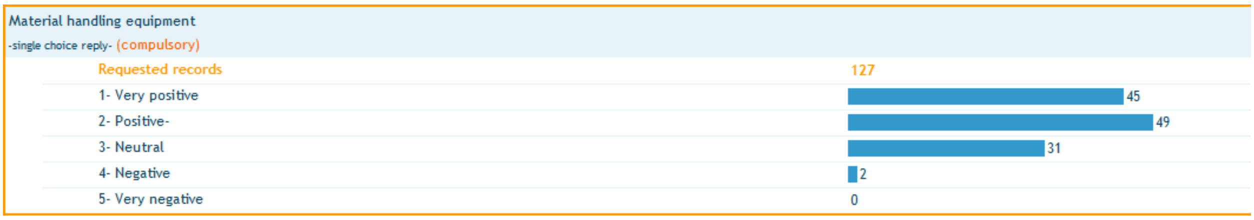
| Energy: hydrogen as a medium for storage of renewable energy<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| 1- Very positive | 75 |
| 2- Positive- | 45 |
| 3- Neutral | 5 |
| 4- Negative | 2 |
| 5- Very negative | 0 |

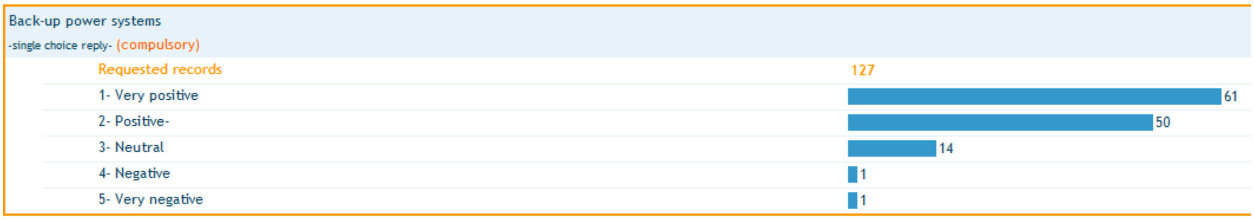
| Hydrogen production: biogas reforming<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| 1- Very positive | 32 |
| 2- Positive- | 47 |
| 3- Neutral | 39 |
| 4- Negative | 7 |
| 5- Very negative | 2 |

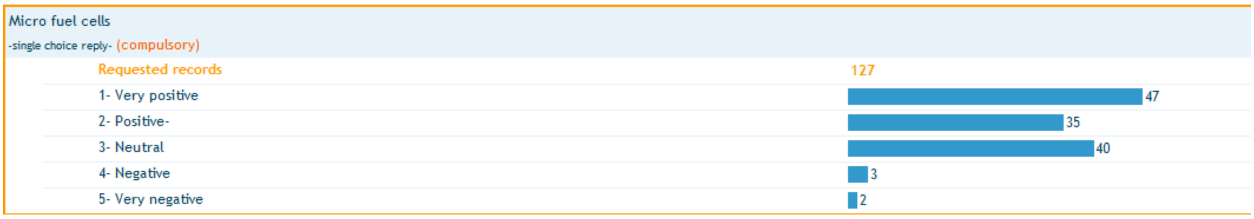
| Hydrogen production: water electrolysis<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| 1- Very positive | 63 |
| 2- Positive- | 42 |
| 3- Neutral | 16 |
| 4- Negative | 6 |
| 5- Very negative | 0 |

| Stationary: micro/residential CHP<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| 1- Very positive | 55 |
| 2- Positive- | 47 |
| 3- Neutral | 22 |
| 4- Negative | 2 |
| 5- Very negative | 1 |

| Stationary: Industrial/commercial CHP<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| 1- Very positive | 50 |
| 2- Positive- | 59 |
| 3- Neutral | 16 |
| 4- Negative | 2 |
| 5- Very negative | 0 |

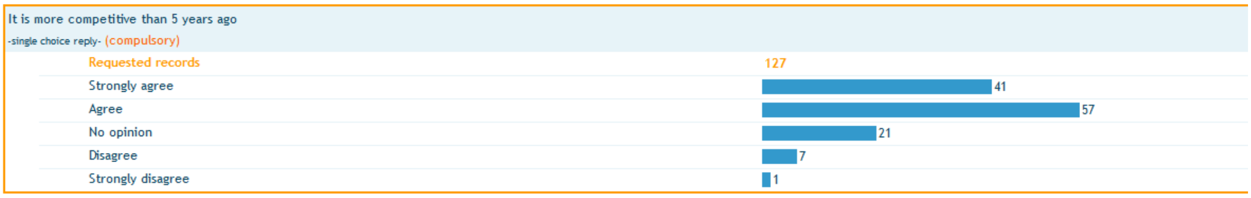


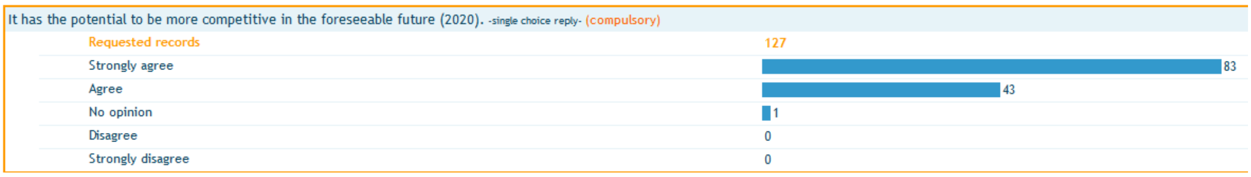




## Identification of the problems

The respondents have mixed views on the European industry: only slightly more than half of the respondents (55%) think that it is competitive on the worldwide scene (20% have no opinion). The past and future trend looks more positive though, with 77% of respondents believing that it is more competitive than 5 years ago, and an impressive 99% believing that the industry has the potential to be more competitive by 2020.


The views on the EU research sector are more positive, 79% thinking that it is competitive today and 77% that it is more than 5 years ago and 95% believing that the European research sector will be stronger by 2020.

| Today, it is competitive on the worldwide scene -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 18 |
| Agree | 82 |
| No opinion | 19 |
| Disagree | 8 |
| Strongly disagree | 0 |

| It is more competitive than 5 years ago -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 36 |
| Agree | 62 |
| No opinion | 20 |
| Disagree | 8 |
| Strongly disagree | 1 |

| It has the potential to be more competitive in the foreseeable future (2020) -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 86 |
| Agree | 34 |
| No opinion | 6 |
| Disagree | 1 |
| Strongly disagree | 0 |

Regarding the main problems faced by Europe, the lack of support of decision makers (87%), of access to risk finance for deployment activities (82%) and of public awareness (75%) are the main problems to be addressed in Europe. Surprising, the lack of competitiveness of the technology comes last in this question (only 37% of respondents agree with this aspect).

| Lack of access to risk finance for deployment activities -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 40 |
| Agree | 64 |
| No opinion | 15 |
| Disagree | 7 |
| Strongly disagree | 1 |

| Lack of technological competitiveness -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 14 |
| Agree | 33 |
| No opinion | 12 |
| Disagree | 65 |
| Strongly disagree | 3 |

| Lack of appropriate Regulations, Codes and Standards -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 29 |
| Agree | 53 |
| No opinion | 21 |
| Disagree | 24 |
| Strongly disagree | 0 |

| Lack of public awareness -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 34 |
| Agree | 62 |
| No opinion | 8 |
| Disagree | 21 |
| Strongly disagree | 2 |

| Lack of public acceptance, problem of perception of safety<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 23 |
| Agree | 61 |
| No opinion | 17 |
| Disagree | 24 |
| Strongly disagree | 2 |

| Lack of awareness and support of decision makers<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 66 |
| Agree | 45 |
| No opinion | 8 |
| Disagree | 8 |
| Strongly disagree | 0 |

| Lack of educated personnel<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 25 |
| Agree | 49 |
| No opinion | 27 |
| Disagree | 24 |
| Strongly disagree | 2 |

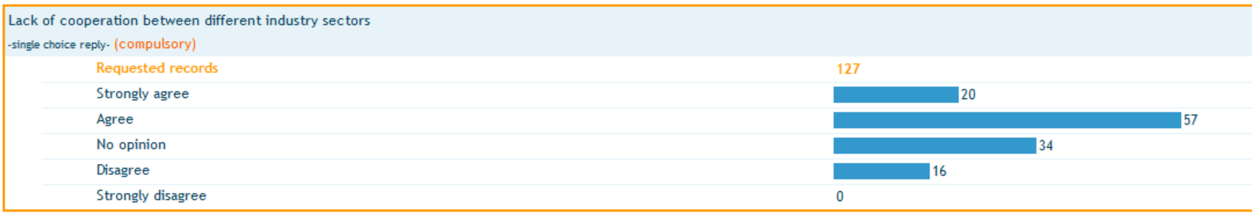
Regarding the underlying problems leading to the issues mentioned above, the lack of public R&D funding is by far the most quoted (81%). Research infrastructure does not seem to be a problem (38%).Other possible underlying problems range from approx. 55% to 65% of agreement.

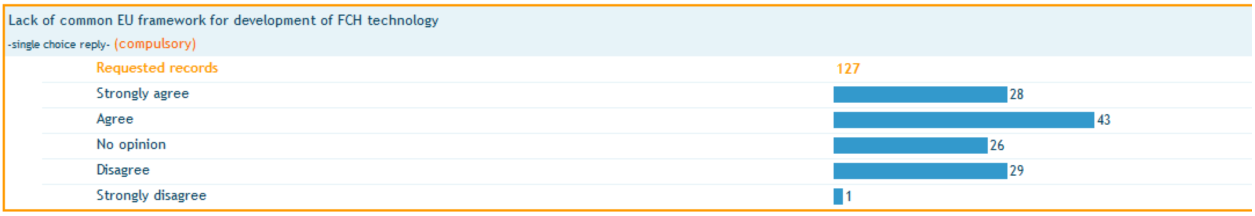
| Lack of public RD&D funding<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 42 |
| Agree | 61 |
| No opinion | 10 |
| Disagree | 14 |
| Strongly disagree | 0 |

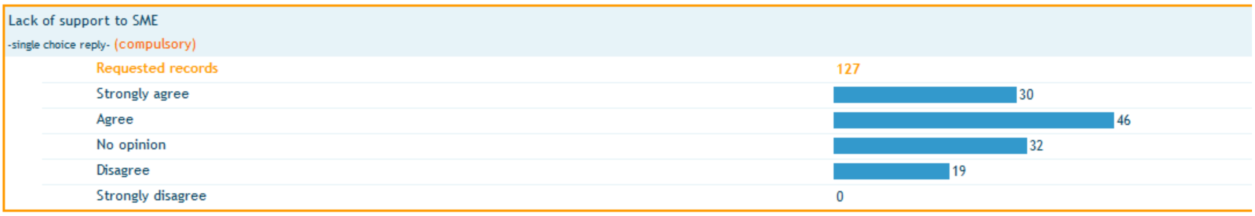
| Lack of private RD&D funding<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 35 |
| Agree | 52 |
| No opinion | 20 |
| Disagree | 17 |
| Strongly disagree | 3 |

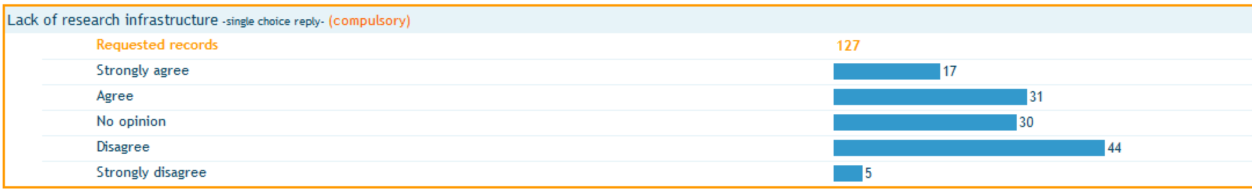
| Lack of coordination between MS and the EU<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 24 |
| Agree | 50 |
| No opinion | 43 |
| Disagree | 9 |
| Strongly disagree | 1 |

| Lack of cooperation between publicly funded and privately funded research<br>-single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 20 |
| Agree | 64 |
| No opinion | 28 |
| Disagree | 14 |
| Strongly disagree | 1 |



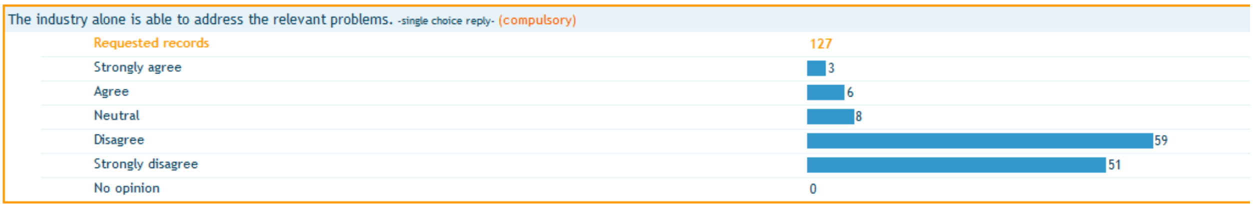



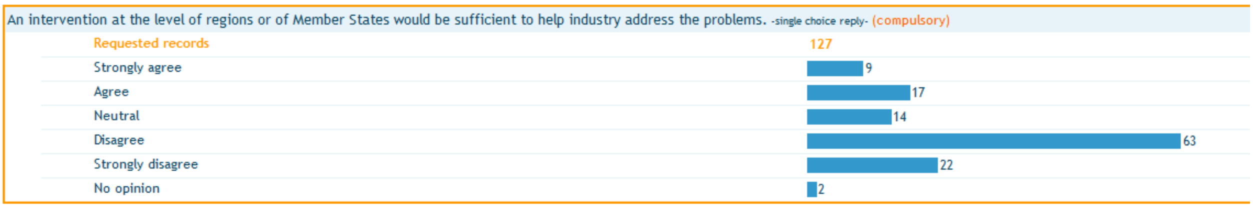



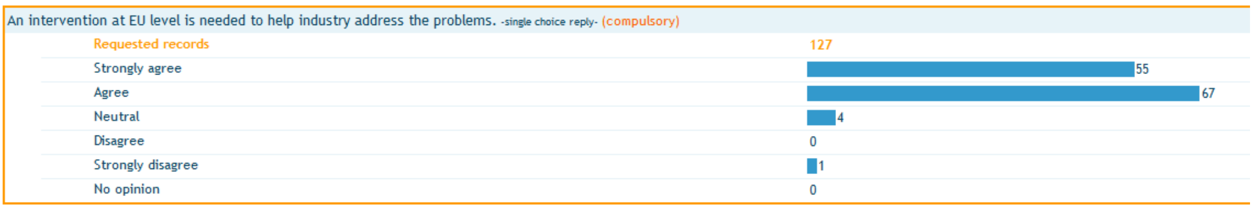




European added value

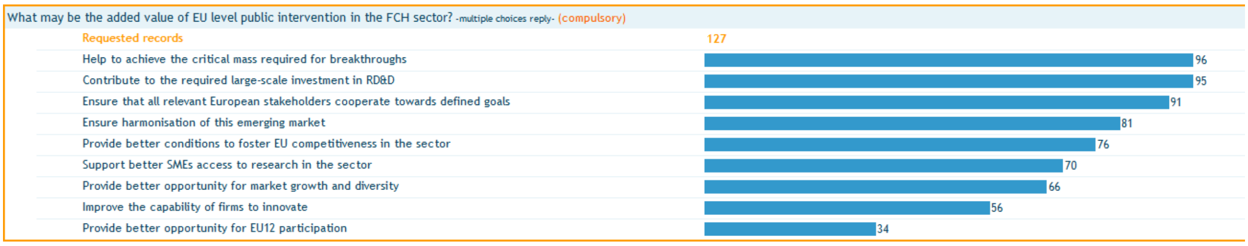
87% of the respondents believe that the industry cannot address the problems alone and 67% that Member States support will not suffice. 96% think that an intervention at EU level is therefore required.



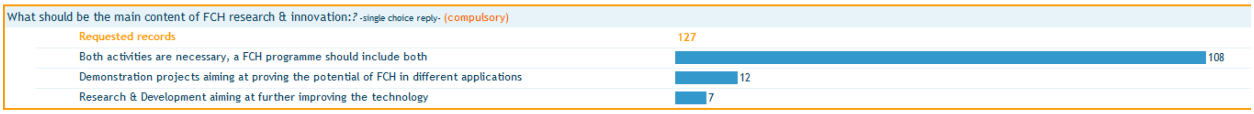

Support to achieve the critical mass required for technological breakthroughs, contribution to the required large-scale investment in R&D and demonstration and definition of common goals for all relevant European stakeholders are the 3 most quoted EU added values (all above 70% of respondents).

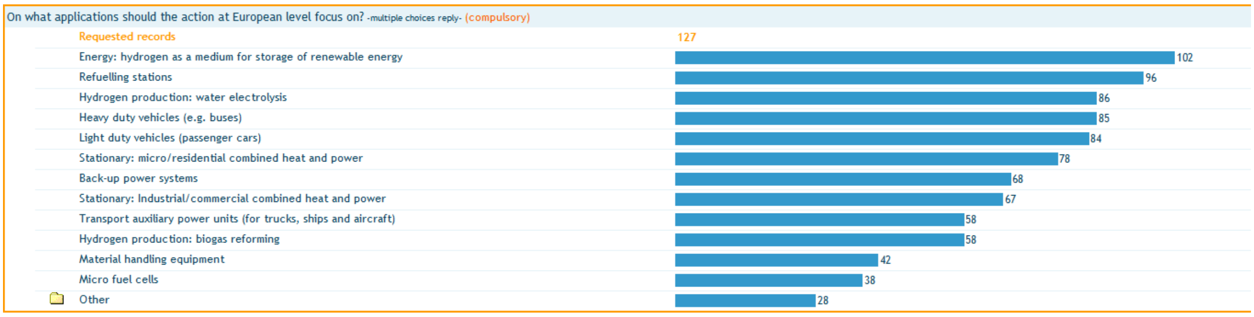



<u>Objectives</u>

85% of the respondents believe that the FCH research & innovation programme should include both research & development and demonstration. There is no wish to see the EU programme focusing to either research or demonstration only.

The 2 most quoted priority applications are hydrogen as a storage medium for renewable energy (80% of support) and refuelling stations for transport applications (75%).



Options and impact

Of the four options considered to implement future research on FCH, only the contractual Public-Private Partnership gathers less than 50% of positive opinions. The favourite option is the continuation of the JU, in a "modernised" format, i.e. different scope and simplified implementation.

| Continue with a Joint Undertaking in the current form of Public-Private Partnership -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 25 |
| Agree | 56 |
| No opinion | 19 |
| Disagree | 22 |
| Strongly disagree | 5 |

| Use of the collaborative research projects under the EU Framework programme -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 22 |
| Agree | 41 |
| No opinion | 21 |
| Disagree | 28 |
| Strongly disagree | 15 |

| Establish a Contractual Public-Private Partnership -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 8 |
| Agree | 26 |
| No opinion | 54 |
| Disagree | 32 |
| Strongly disagree | 7 |

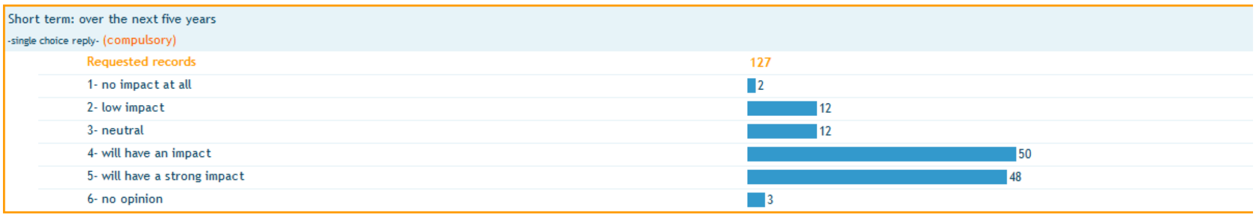
| Continue with a Joint Undertaking but with a different scope and simplified implementation -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Strongly agree | 63 |
| Agree | 33 |
| No opinion | 18 |
| Disagree | 12 |
| Strongly disagree | 1 |

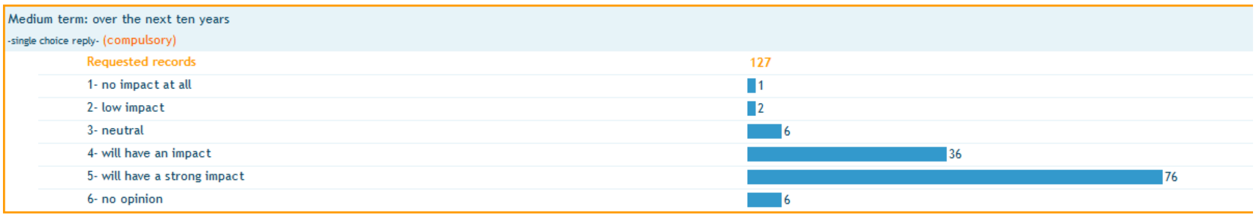
| Which one is your favoured option? -single choice reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Continuation of current Joint Undertaking | 21 |
| Collaborative research | 27 |
| Contractual Public-Private Partnership. | 5 |
| Modernised Joint Undertaking | 68 |
| No opinion | 6 |

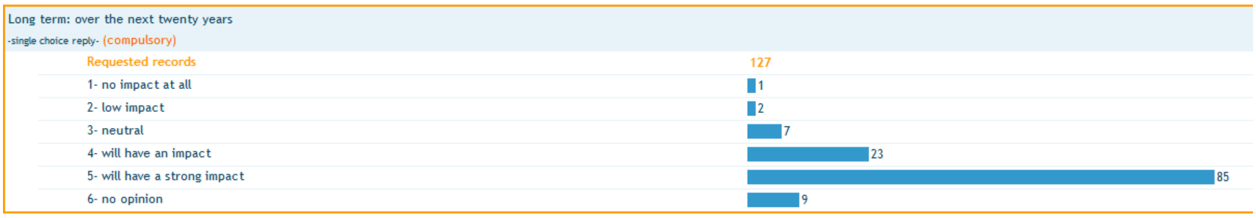
More than 67% of respondents believe that the aim and scope of the initiative should go beyond RD&D and include support to deployment activities and close to 50% that the budget should evolve (i.e. increase).

| If the FCH JU was to be continued, which of the following topics should be improved compared to the current initiative? -multiple choices reply- (compulsory) | |
|---|---|
| Requested records | 127 |
| Aim and scope of the initiative, which should go beyond RD&D and include support to deployment activities | 86 |
| Technology objectives | 43 |
| Governing structure | 31 |
| Budget | 60 |
| Rules for participation and dissemination | 45 |
| No opinion | 9 |

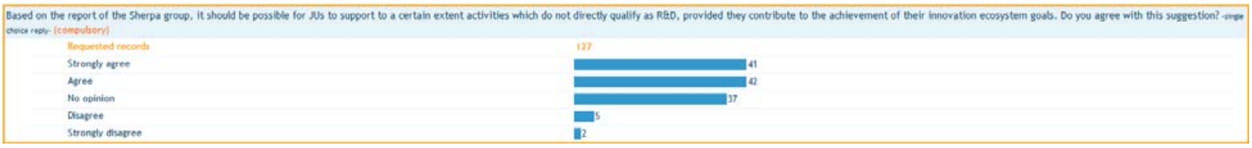
Most respondents believe that the FCH JU will have an impact on the EU competitiveness, this impact increasing over time (77% of positive feedback at short-term, 88% at medium-term and 84% at long-term).



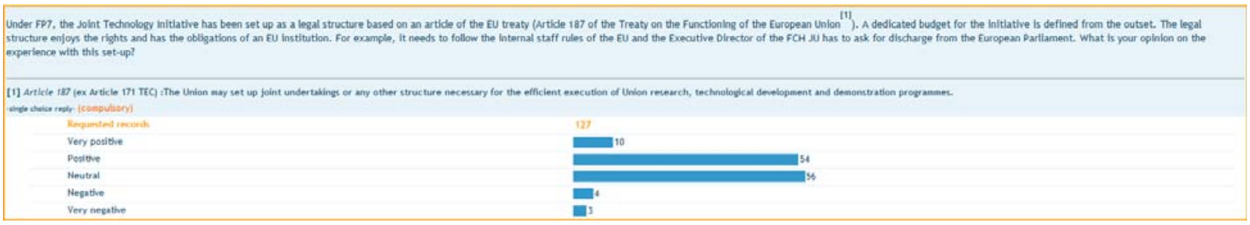




65% of the respondents support the recommendation of the Sherpa group, i.e that it should be possible for JUs to support to a certain extent activities which do not directly qualify as R&D, provided they contribute to the achievement of their innovation ecosystem goals.




50% of the respondents have a positive opinion on the establishment of the Joint Technology Initiatives.




The majority of the respondents think that the FCH JU has reach most of the EU objectives. In order of importance, they believe this mechanism has provided medium-term stability on RD&D public funding for the FCH sector (79% of respondents), has contributed to increase European competitiveness (76%), has increased and improved coordination between stakeholders at EU level (72%) and has increased the involvement of the industry in RD&D on FCH (71%). Many other aspects score above the 50% satisfaction. Some fields below the 50% mark will require attention for the future (EU-12, outreach, simplification of access to funding).

It has contributed to the objective of significantly accelerate the market introduction of the fuel cell and hydrogen technologies

-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 23 |
| Agree | 63 |
| Neutral | 24 |
| Disagree | 8 |
| Strongly disagree | 0 |
| No opinion | 9 |

It has contributed to provide medium-term stability on RD&D public funding for the FCH sector

-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 37 |
| Agree | 63 |
| Neutral | 14 |
| Disagree | 5 |
| Strongly disagree | 0 |
| No opinion | 8 |

It has triggered additional private RD&D funding

-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 23 |
| Agree | 58 |
| Neutral | 25 |
| Disagree | 10 |
| Strongly disagree | 0 |
| No opinion | 11 |

It has contributed to increase European competitiveness

-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 21 |
| Agree | 76 |
| Neutral | 18 |
| Disagree | 4 |
| Strongly disagree | 0 |
| No opinion | 8 |

It has contributed to increase and improve coordination between stakeholders at EU level

-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 36 |
| Agree | 56 |
| Neutral | 19 |
| Disagree | 4 |
| Strongly disagree | 3 |
| No opinion | 9 |

It has contributed to simplify the management and access to EC funding for RD&D on FCH

-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 8 |
| Agree | 41 |
| Neutral | 40 |
| Disagree | 20 |
| Strongly disagree | 5 |
| No opinion | 13 |

It is a useful single entry point for support on RD&D for FCH for different applications
-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 35 |
| Agree | 49 |
| Neutral | 22 |
| Disagree | 11 |
| Strongly disagree | 2 |
| No opinion | 8 |

It has contributed to increase the involvement of the industry in RD&D on FCH -single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 30 |
| Agree | 60 |
| Neutral | 22 |
| Disagree | 5 |
| Strongly disagree | 0 |
| No opinion | 10 |

It has contributed to increase the involvement of SMEs in RD&D on FCH -single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 15 |
| Agree | 54 |
| Neutral | 31 |
| Disagree | 7 |
| Strongly disagree | 6 |
| No opinion | 14 |

It has contributed to increase the EU-12 involvement in RD&D on FCH
-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 12 |
| Agree | 37 |
| Neutral | 46 |
| Disagree | 13 |
| Strongly disagree | 1 |
| No opinion | 18 |

It has contributed to improve the EU presence at international level
-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 24 |
| Agree | 63 |
| Neutral | 25 |
| Disagree | 6 |
| Strongly disagree | 1 |
| No opinion | 8 |

It has contributed to increase the outreach of the FCH sector to less-informed publics (wider public)
-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 8 |
| Agree | 54 |
| Neutral | 32 |
| Disagree | 20 |
| Strongly disagree | 4 |
| No opinion | 9 |

It has contributed to increase the outreach of the FCH sector to decision makers
-single choice reply- (compulsory)

| | |
|---|---|
| Requested records | 127 |
| Strongly agree | 15 |
| Agree | 54 |
| Neutral | 37 |
| Disagree | 6 |
| Strongly disagree | 4 |
| No opinion | 11 |

## Annex 4 - Public consultation and stakeholder survey: difference and overlap between respondents; minority views

**Affiliation of respondents (154) to the stakeholder survey**

Most respondents are large companies (30%) or SMEs (27%), followed by research centres (public: 13% and private: 13%). Universities account for 7.8%. Half of the private industries (large enterprises and SMEs) are members of the Industry Grouping.

**Affiliation of respondents (127) to the public consultation**

Most respondents are individual citizens (28%), followed by SMEs and research organisations (19% each). Large businesses represent 14%, business organisations 5.5%, NGOs 4.7% and MS and regional administrations around 2% each.

**In total, 34 respondents have answered to both surveys.**

- 7 large companies (incl. 6 Industry Grouping)
- 9 SMEs (incl. 8 Industry Grouping)
- 11 research centres (private, public, universities) – some repeated (several people of the same organisation)
- 1 business organisation
- 4 citizens from research entities
- The Industry Grouping and Research Grouping as business/research organisations did take part to the public consultation

**Minority views**

One out of 127 respondents of the **public consultation** disagreed with the need of an EU intervention for R&D on FCH. Analysing the other answers to the questions, it might actually be a mistake. This company, which wishes to remain anonymous, is very active in the current JU, has a positive opinion of the current JU and favour a 'modernised' JU for Horizon 2020.

Thirteen out of 127 respondents (10%) of the **public consultation** disagreed with the favoured option of a modernised JU. They are equally distributed in the research centres, SMEs and large businesses. 2 groups can be identified:

- Either they favour collaborative research or a contractual PPP to align participation rules and (more importantly) funding rates with the framework programme;

- Or they wish to continue the current JU as it is today, to ensure continuity with a tool that they perceived positively.

Seven per cent of the respondents to the **stakeholder survey** do not favour a continuation of the Joint Undertaking (10 entities). These include 2 large companies (members of the NEW-IG), 3 research centres and 3 universities. The criticism is the following:

- Low and unpredictable funding rates with respect to FP7;

- No reduction of the administration effort to prepare and implement projects;

- The industry-led FCH JU created a gap between Future Emerging Technology (FET) concepts of the FP programme and industry-focused targets required by the Annual Implementation Plans.

## Annex 5 - Relevance of FCH technologies to Societal Challenges

**Climate change**. Fuel cells and hydrogen offer the possibility of GHG reductions in transport industry, the tertiary sector and in power generation. In transport the impact is potentially very high and strategically significant as the alternatives to hydrocarbons for transport are few. The Roadmap for moving to a competitive low carbon economy in 2050 produced by the Commission prescribes the most cost-effective path to achieve the EU target of an 80-95% reduction by of greenhouse gas emissions in 2050 compared to 1990; the Roadmap estimates that a reduction of emissions from transport of between 54% and 67% compared to 1990 will be needed[38]. Decarbonisation of electricity production is the centre-piece of the strategy; the virtual decarbonisation of electricity by 2050 has the consequence that the impact of vehicles using electric drives on greenhouse gas emissions can exceed the 2050 targets.

Hydrogen storage can be an important adjunct to renewable energy and greatly facilitate the achievement of the decarbonisation goals for the power sector. Renewable energy is intermittent and only partially predictable. Wind power, which is a major future source of renewable energy in Europe, is especially problematic and subject to hourly, daily and weekly fluctuations. This complicates the planning and operation of power systems with large quantities of renewables. Shortfalls in renewable energy can be met by back-up conventional generating plant, but this will increase GHG emissions. An alternative is to use surplus renewable energy to produce hydrogen by electrolysis and then to generate electricity in a fuel cell at a time when costs on the power system are high.

Fuel cells may be used for stationary power generation in the same way as any other generator. The fuel supply will be a hydrocarbon either fossil or from biomass. The commercial impact will depend upon how it compares in terms of capital and operating costs with conventional electro-mechanical generators. There may be a more promising application for small CHP units in the residential and tertiary sector as the units will be quiet and can achieve high efficiencies. There is potentially a very large market in the residential sector, but the impacts on climate change through emissions of GHG in Europe may be relatively low. The main load in the residential sector is for low temperature heat for space heating. Condensing boilers are extremely efficient in this application; the savings in fuel use from associated electricity generation in a residential CHP unit may therefore be small. If the decarbonisation goals for the power grid are met then the carbon intensity of electricity generation will fall dramatically and the benefits in GHG emissions from the CHP units will be even smaller. This analysis is borne out by case studies and theoretical modelling of micro-CHP in the UK[39].

The commercial impact of CHP applications is more promising where the heat to power ratio is higher and/or the delivery temperature of the heat is higher (mainly industry or commercial properties with high demands for hot water). The impact on the societal costs of carbon will be greater in countries where the carbon intensity of grid generation is high (e.g. China). Export markets would thus have greater impact on climate change than domestic markets.

[38] A Roadmap for moving to a competitive low carbon economy in 2050, COM (2011)112

[39] Micro-CHP Accelerator, Carbon Trust, March 2011

**Energy security.** Security of supply is a central of energy policy laid down in the Lisbon Treaty[40], but EU-27 dependency on energy imports has increased from less than 40 % of gross energy consumption in the 1980s to 45.1 % in 1999 and then to 53.9 % by 2009[41]. Decarbonisation of electricity supply has the advantage of improving energy security because the likely primary sources would be renewable energy, nuclear and fossil-fuels with carbon capture and storage (CCS). Security can be further enhanced if mobility is provided through electric vehicles because, as long as constraints on low carbon resources are not binding, the security of electricity supply is passed through to security of mobility. Applications of hydrogen for transport, as a storage medium for electricity and for stationary power generation including CHP can all potentially improve energy security. In particular, the use of hydrogen as storage medium for renewable energy is indeed a priority for Europe in the near future. The stakeholders' survey shows that the private sector has already integrated this trend in their planning, as their turnover is expected to grow strongest in the hydrogen production and storage application until 2020 (23% annual increase) Equally, the R&D for this application will grow 28% annually.

**Employment.** Hydrogen and fuel cells have direct, indirect and induced impacts on jobs and growth. If fuel-cell applications simply replace conventional applications in providing energy services without gain or loss in the presence of European companies in the value chains for those services, then the overall impact on employment is likely to be modest. This conclusion may change depending upon whether Europe manages to extend its export markets by gaining first-mover advantage in FCH technology, or whether it loses market share as a consequence of a deficiency in research and development. This issue is especially acute for mobility, where Europe is at present a major international provider and a few percentage points either way in its international market presence could have large implications for employment.

**International competition**. If European companies are able to forge a lead in hydrogen technologies, and if the technology proves to be viable internationally then European global competitiveness will be fostered. As noted by the European strategy on clean and energy efficient vehicles, the European automotive industry is a world leader in developing clean and energy efficient technologies based on combustion engines; this is a consequence of substantial investment over some fifteen years of research and development. It is also a crucial European industry, competitive, innovative and supporting a wide range of related sectors[42].

**Technological development and innovation.** R&D in this field will stimulate technological innovation across a wide range of disciplines including: surface chemistry; catalysis; membranes; nanotechnology; materials and control engineering. There is also an indirect influence on innovation in grid technology as the ability to produce and to store hydrogen at off-peak periods and to interrupt hydrogen production again in favour of electricity at peak times can be an advantage for intermittent renewable energy sources and can stimulate innovation in smart grid technologies.

Value chains in the transport sector will need to adjust, but there will also be complex implications of stationary power generation on relationships in the power industry. It is not

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40 Article 194 of the Consolidated Version of the Treaty on The Functioning of the European Union, O.J., 30.3.2010

41 Energy production and imports, www.epp.eurostat.ec.europa.eu/statistics_explained/index.php/Energy_production_and_imports

42 A European strategy on clean and energy efficient vehicles, COM(2010)186

evident that generators on the central power system would wish to own and operate large-scale hydrogen storage; the technologies involved are quite different from conventional electro-mechanical systems. The same is true for distribution operators. It may be that natural gas companies would be best placed. Whatever the ownership, there would however need to be constructive relationships with distributors within the overall concept of a smart grid. The development and deployment of storage solutions will therefore need new R&D partnerships and eventually new business models.

**SMEs**. The value chain of the automotive industry generally comprises assemblers, global mega-suppliers, first-tier suppliers, second-tier suppliers, third-tier suppliers and the aftermarket. A shift to low-carbon vehicles and to fuel cell vehicles in particular, gives to European manufacturers and SMEs the chance to reassert market leadership in the technologies of the future. Vehicle manufacturers should set goals for the SMEs regarding quality, reliability and cost and work with them to develop the designs and engineering processes that will meet the goals. As the FCEV programme is rolled out, eventually on a global scale, so the SMEs will evolve in parallel towards Tier 2 or Tier 1 suppliers.

**Health.** Zero-emission power trains do not generate local pollution in their "tank-to-wheel" process. The recently completed Aphekom project on 25 selected cities of Europe of varying character and size calculated that the economic cost of local pollution was €31.5 billion[43]. The impacts and costs are proportionally greater when extrapolated from the sample of 25 cities to the whole of Europe. Europe is heavily urbanised; at present 72% of Europeans live in urban areas; this will increase to around 80 % of Europeans by 2020; in several countries the proportion will be 90 % or more[44]. These impacts would be eliminated by FCEVs.

**Consumers.** Consumers will have to pay more for mobility whatever technical option is chosen in the future. The value of the FCEV over alternative power-trains in terms of total cost of ownership (including the cost of the hydrogen infrastructure) is positive beyond 2030. The extra cost per tonne of carbon saved is equivalent to an abatement cost of carbon of between €150 - €200 per tonne in 2030, which is somewhat higher than the values calculated for example by the UK[45] and French[46] governments, but it becomes negative after 2030 as the relative costs of ICEs and FCEVs move favourably for the FCEV. Applications of hydrogen storage in power systems will reduce the costs of decarbonisation of electricity supply and therefore lower electricity bills. There may also be consumer benefits from residential CHP applications, but this will require a large decrease in the costs of fuel cells if they are to compete with condensing boilers and grid supplies.

**Government budgets.** Deployment of transport applications will make a significant impact on government budgets because it is unlikely that either consumers or vehicle manufacturers will accept to pay the entirety of the extra costs. State contributions to infrastructure will be needed as well as fiscal incentives to first-adopters of vehicles. A roll-out of 100,000 FCEVs in 2015, 1 million in 2020 and a 25% share of the total EU passenger car market in 2050 will

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43 Summary report of the Aphekom project 2008-2011: Improving Knowledge and Communication for Decision Making on Air Pollution and Health in Europe, www.aphekom.org

44 Urbanisation in Europe: limits to spatial growth, Uhel, R., EEA. Key note speech to the 44th International Planning Congress, 20th September 2008, Dalian, China. http://www.eea.europa.eu/pressroom/speeches/urbanisation-in-europe-limits-to-spatial-growth

45 The UK Low Carbon Transition Plan, DECC (July 2009).

46 La valeur tutélaire du carbone, Alain Quinet, et al., La Documentation Française - Paris, mars 2009

accumulate a loss of €25 billion by 2020 compared to an ICE scenario, mainly arising from the extra cost of the vehicles. After 2030, the technology should be competitive.

Hydrogen storage options to complement renewable deployment are also likely to need initial government support. At prevailing prices multi-day hydrogen storage is not economic and support, perhaps in the form of a feed-in tariff for fuel cells deployed in this manner will be needed. This should be time-limited as, if the planned renewable penetration is achieved, the technology should be commercial in the medium-term.

Residential, commercial and tertiary applications of stationary power will also need support if it is considered socially desirable that they proceed. Germany has introduced several subsidy schemes for fuel cell CHP in all sectors; the UK had a limited feed-in tariff for micro-CHP. These support schemes will need to be sustained and extended to other countries if a rapid take-up of the technology is thought desirable.

# Annex 6 - Status and targets of FCH technology

Key Performance Indicators are consistent with the current Multi-Annual Implementation Plan (MAIP) of the FCH JU

| | Description | 2008 status | 2012 current status | 2016 target | 2020 target | Key FCH JU projects contributing to achieving the specific target |
|---|---|---|---|---|---|---|
| Transport | Automotive (PEM) fuel cell system cost | >1000 €/kW | >500 €/kW | 100 €/kW | 50 €/kW | H2moves (19 cars), HyTEC (obj. up to 35 cars), SWARM (obj. 90 cars) |
| | Automotive (PEM) fuel cell system lifetime | 2,000 h | 2,500 h | 4,000 h | 5,000 h | |
| | Automotive vehicle cost | 500 k€ | 200 k€ | 50 k€ | 30 k€ | |
| | Bus fuel cell system cost | >3500 €/kW | <3500 €/kW | <2000 €/kW | <400 €/kW | |
| | Bus fuel cell system lifetime | 6,000 h | 6,000 h | 9,000 h | 12,000 h | |
| | Bus vehicle cost | 2,000 k€ | 1,300 k€ | <1,000 k€ | <500 k€ | |
| | Hydrogen refuelling stations | <60 | ~80 | <300 | >2000 | CHIC (26 buses, 5 stations), High V.Lo-City (14 buses, 2 stations), HyTransit (obj. 6 buses, 1 stations)* |
| | Hydrogen refuelling stations cost [per unit] | 1 - 3 M€ | 0.7 - 2 M€ | 0.6 – 1.8 M€ | 0.6 - 1.6 M€ | |
| | Hydrogen price at dispensing pump | 15-20 €/kg | > €10/kg | 5-10 €/kg | 5 €/kg | PHAEDRUS; Don Quichote (obj 2015: 13€/kg, 2020: <7 €/kg) |
| | Material handling vehicles FC system cost | <7,000 €/kW | <4,000 €/kW | <1,500 €/kW | <1,000 €/kW | HyLIFT-DEMO (+10 units), HyLIFT-Europe (obj. 200 units), SHEL (10 units) |
| | APU for truck applications (3 kW) cost | >12,000 €/kW | >6,000 €/kW | <3,000 €/kW | <1,500 €/kW | DESTA, FCGEN |
| Energy | H2 production electrolysis, energy consumption (kWh/kg) | 67 @ 1/kg/d | 57-60 @100kg/d** | 55 @500kg/d | 52 @1000+kg/d | PrimoLyser (55 kWh/kg), Don Quichote (obj. <50 kWh/kg) |
| | Distributed H2 production electrolysis, CAPEX | 10 M€/(t/d) | 8.0 M€/(t/d) | 4.0 M€/(t/d) | 2.0 M€/(t/d) | |
| | Distributed H2 production from biogas, CAPEX | | 4.2 M€/(t/d) | 3.8 M€/(t/d) | 2.5 M€/(t/d) | CoMETHy, Hytime |
| | Distributed storage of gaseous hydrogen, CAPEX | 1.0 M€/t | 0.5 M€/t | 0.45 M€/t | 0.4 M€/t | |
| | Storage of hydrogen in solid materials, CAPEX | 10 M€/t | 5 M€/t | 1.5 M€/t | 0.85 M€/t | SSH2S |
| | High capacity compressed hydrogen gas trailer, CAPEX | 0.55 M€/t (300 kg cap) | 0.55 M€/t (400 kg cap) | 0.55 M€/t (800 kg cap) | 0.45 M€/t (1000 kg cap) | DeliverHy |
| | Micro-CHP (residential), natural gas based (1 kWe) | | -- | 10 k€/syst. | 5 k€/syst. | SOFT-PACT (100 units, < 4 k€/kW) Ene.field (960 units, < 10 k€/kW) |
| | Industrial/commercial CHP, H2 based | Xx €/kW | 4,500 €/kW | 3,000 €/kW | 1,500 €/kW | ClearGenDemo (1MW, 2500 €/kW) POWER-UP (750kW, < 3000 €/kW) |
| | Industrial/commercial CHP, natural gas based | Xx €/kW | Xx €/kW | 4,000 €/kW | 2,000 €/kW | |
| | Back-up power, fuel cell system cost | Xx €/kW | 5,000€/kW | 1.500€/kW | 850€/kW | FITUP(19 units) |

*HyTransit and High V.Lo-City share a station in Aberdeen to fuel a total of 10 buses

** The range is caused by different technology development stages for alkaline and PEM and different output pressures

## Annex 7 - Success stories

In the area of *transportation and refuelling infrastructure*, dominated so far by large demonstration projects, more than 40 FCEV and more than 40 buses are being tested in real condition (approx. 10% of worldwide fleet), with more vehicles expected to be rolled-out. For example, the project CHIC aims at integrating 26 FCH buses in daily public transport operations in five locations across Europe. The project is supported by the FCH JU with funding of €26 million (total cost is €81.9 million), and has 25 partners from across Europe, which include industrial partners for vehicle supply and refuelling infrastructure, academics, local authorities and operators.

ITM Power has become one of the world leading PEM electrolyser manufacturers thanks to the bottom-up approach of the FCH JU. It has developed a number of commercial applications such as the recently deployed HFuel vehicle refuelling unit. ITM Power achieved its progress due to participation in FP7 projects as well as in FCH JU projects like ELECTROHYPEM.

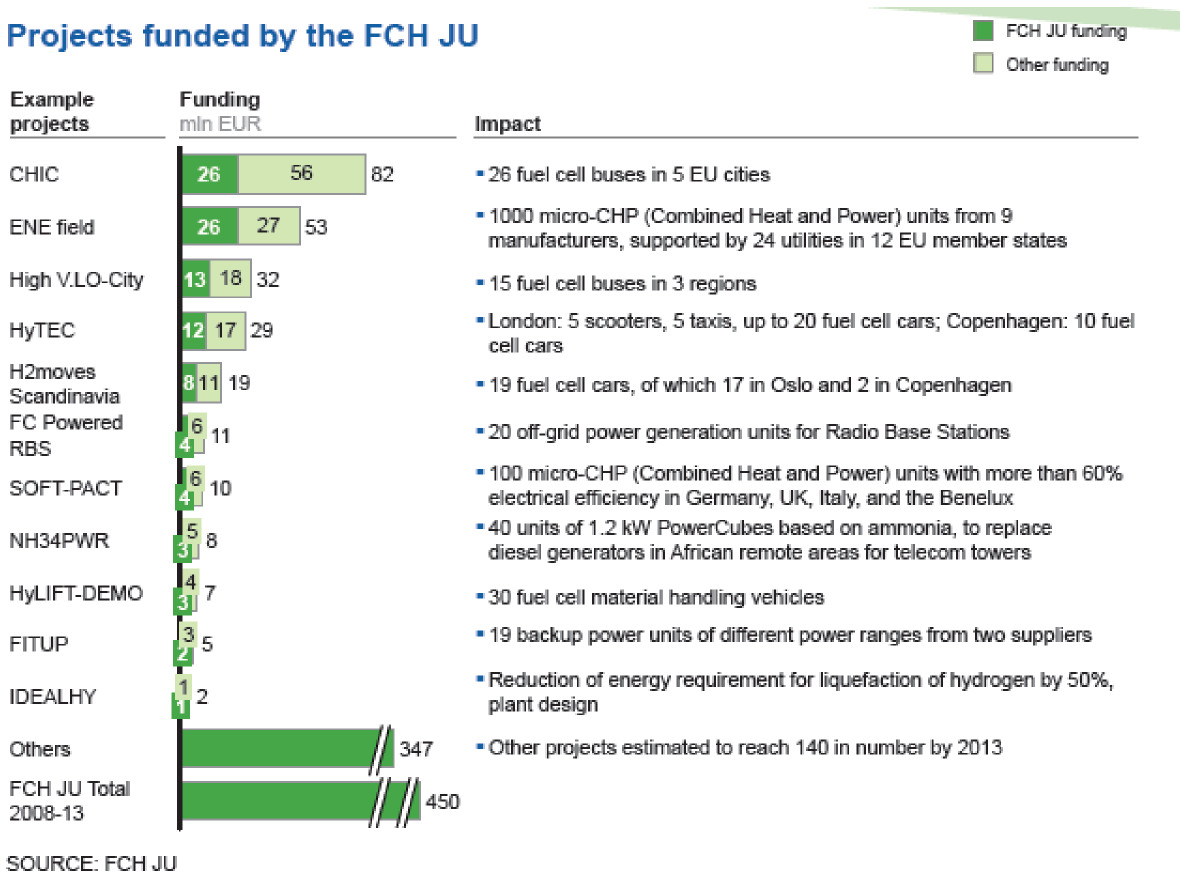
Stationary and CHP projects in the FCH JU focus primarily on the RTD pathway – understanding degradation and lifetime fundamentals, through applied research related to component improvement, control and diagnostics to advance the area to a position of being successfully demonstrated.

One of the leading companies in the field, SOFCpower S.P.A., is specialised in high temperature electro-ceramic devices based on Solid Oxide Fuel Cells technology. SOFCpower is involved in 11 FCH JU and FP7 projects, where it obtained expertise in residential micro-CHP, improved stack durability, control strategy and diagnostics and strategic long-term development for new or improved products. Another key player, Nedstack (the largest fuel cell stack producer in Europe) participates in the FCH JU project IRAFC, in which an Internal Reforming Alcohol High Temperature PEFC Stack is being developed. This system can be applied in various areas such as portable fuel cells, stationary back-up and UPS systems and remote and off grid areas.

The *early markets* portfolio covers different sectors such as forklifts, back-up power, portable applications and micro fuel cells. With support of the FCH JU, the Danish based SME H2Logic A/S has developed and facilitated the commercialisation of its two innovative products: H2Station® - Hydrogen refuelling stations for automotive, bus and materials handling applications, and H2Drive® - Fuel cell systems for materials handling vehicles such as forklift trucks and airport tow tractors. The company´s first move was supported by Danish national programmes and the Nordic Energy Research; the further optimisation of a cost effective fuel cell system was carried out in the FCH JU- supported HyLift-DEMO-project. In 2011, H2Logic A/S installed four 70MPa H2Stations in less than 12 months; one of them operates on the premises of SINTEF as part of the FCH JU H2moves Project - the large scale demonstration of fuel cell vehicles and refuelling infrastructure in Oslo.

The *hydrogen production and distribution* portfolio mainly focuses on research and development. One of the FCH JU flagship projects, ADEL, brings together a high level European consortium in the field of Intermediate Temperature Steam Electrolysis coupled to renewable energy sources for efficient hydrogen production. The ADEL project develops a new steam electrolyser concept that should optimise the electrolyser life time by decreasing its operating temperature while maintaining satisfactory performance level and high energy efficiency. The device will first target the current H2 market and, in the mid-term, will be used for carbon free transportation applications. In addition, the technology will be applied in the field of long-term energy storage. The FCH JU will fund €2 million of the total €4.1 million. More recently, the project Don Quichote has been launched. Its focus is the extensive demonstration of hydrogen production by renewable electricity, and the compression, storage and end use of hydrogen in transport applications or for grid balancing. The project will show that the use of hydrogen as a large scale renewable energy storage solution can be an interesting business case for end customers. It will demonstrate system level technology readiness, as well as conduct R&D on PEM electrolysis and novel cost-effective and compact compression technology. The JU contributes €2.9 million to the total budget of €4.9 million.

Last but not least, European Summer Schools on FCH technology were started within the framework of the FP6 projects Real-SOFC & LargeSOFC. These Summer Schools continued successfully in the FCH JU project "TrainHy" and have contributed in educating more than 300 PhD students and young professionals from industry. Several FCH companies heavily relied on this activity as an element of training for their new staff.



# Annex 8 - Results of the Call for Proposals of the FCH JU

| | Indicator | EC management | FCH JU (transition) | | FCH JU (full autonomy) | | | FCH JU* |
|---|---|---|---|---|---|---|---|---|
| | | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2008-2012 |
| submission stage | amount (million €) | not specified | 28,1 | 71,3 | 89,1 | 109 | 77,5 | 375 |
| | nb proposals submitted (eligible) | 87 | 32 | 49 | 69 | 80 | 78 | 308 |
| | nb of participations | 721 | 243 | 400 | 559 | 666 | 550 | 2418 |
| | nb of countries | 41 (EU: 24) | 24 (EU: 18) | 25 (EU: 17) | 32 (EU-20) | 37 (EU-23) | 30 (EU: 21) | 43 (EU-25) |
| | nb of private entities (industry + SME) | 202 | 104 | 192 | 285 | 331 | 295 | 1207 |
| | % of private entities (industry + SME) | 28% | 43% | 48% | 51% | 50% | 54% | 50% |
| | nb of SME | 142 | 78 | 103 | 140 | 174 | 168 | 663 |
| | %of SME | 20% | 32% | 26% | 25% | 26% | 31% | 27% |
| | nb of EU-12 participants | 58 | 11 | 9 | 27 | 35 | 30 | 112 |
| | % of EU-12 participants | 8,0% | 4,5% | 2,3% | 4,8% | 5,3% | 5,5% | 4,6% |
| | requested EC contribution (million €) | 255,4 | 68,5 | 129,6 | 230,6 | 282,4 | 259,5 | 970,6 |
| | % contribution to private entities | 24% | 45% | 60% | 59% | 49% | 59% | 58% |
| | % contribution to SME | 19% | 32% | 23% | 24% | 26% | 31% | 27% |
| | % contribution to EU-12 | 6,4% | 3,0% | 1,2% | 3,2% | 4,8% | 3,9% | 3,6% |
| awarded contracts | nb of project funded | 9 | 16 | 28 | 27 | 33 | 28 | 132 |
| | succes rate | 10% | 50% | 57% | 39% | 41% | 36% | 43% |
| | nb of participations | 70 | 129 | 244 | 210 | 304 | 223 | 1110 |
| | nb of countries | 17 (EU: 14) | 19 (EU: 15) | 20 (EU: 14) | 18 (EU: 15) | 26 (EU: 17) | 21 (EU: 16) | 32 (EU: 19) |
| | nb of private entities (industry + SME) | 25 | 63 | 138 | 113 | 157 | 124 | 595 |
| | % of private entities (industry + SME) | 36% | 49% | 57% | 54% | 52% | 56% | 53,6% |
| | nb of SME | 10 | 26 | 46 | 55 | 70 | 56 | 253 |
| | %of SME | 14,30% | 20,2% | 18,9% | 26,2% | 23,0% | 25,1% | 22,8% |
| | nb of EU-12 participants | 4 | 5 | 3 | 5 | 13 | 10 | 36 |
| | % of EU-12 participants | 5,7% | 3,9% | 1,2% | 2,4% | 4,3% | 4,5% | 3,2% |
| | final EC contribution | 24,62 | 27,2 | 72,53 | 83,7 | 119 | 88,4 | 391 |
| | Private entities funding (industry + SME) | 24,10% | 57,40% | 71% | 65% | 67% | 63,60% | 65,9% |
| | SME funding | 9,50% | 27,10% | 19% | 24% | 30% | 26% | 25,6% |
| | EU-12 funding | 2,50% | 1,90% | 0,4% | 1,5% | 4,6% | 2,80% | 2,6% |

*Key data regarding the results of the 5 calls for Proposals launched under the FCJ JU. In addition, data on the 1st FP7 call and last managed by the EC is provided. Note: the results of the 2012 call are indicative, as negotiations are ongoung. Source: FCH JU Annual Activity reports and EC Annual Progress reports 2008, 2009, 2010, 2011 and 2012(* for "awarded contracts", the figures cover the period 2008-2011).*

| Application Areas | TOTAL | |
|---|---|---|
| | €m % | |
| Transportation & Refuelling Infrastructure | 109 (144-162) | 36 (32-36%) |
| Hydrogen Production & Distribution | 36 (45-54) | 12 (10-12%) |
| Stationary Power Generation & CHP | 106 (154-167) | 35 (34-37%) |
| Early Market | 43 (54-63) | 14 (12-14%) |
| Cross-cutting Issues | 8,1 (27-36) | 2,7 (6-8%) |
| TOTAL (€m) | 302 (450) | 100% |

Achieved and targeted (in brackets) deployment of resources by application area (2008-2011)

| Application Areas | TOTAL | |
|---|---|---|
| | €m % | |
| Basic research | 69 (60-68) | 23 (13-15%) |
| Research & technological development | 78 (142-157) | 26 (31-35%) |
| Demonstrations | 137 (183-208) | 45 (41-46%) |
| Support actions | 18 (39-49) | 6 (9-11%) |
| TOTAL (€m) | 302 (450) | 100% |

Achieved and targeted (in brackets) deployment of resources by project type (2008-2011)

## Annex 9 - Challenges with respect to complexity and cost-effectiveness

Notable examples of the Shortcomings with respect to the implementation of JTIs as identified by the Sherpa report, the JTI interim evaluations, the CoA reports on JTIs, etc.

- Lack of tailoring of legal framework. The legal framework governing a JU is essentially composed of four elements: the Council Regulation, the Statutes, the JU's own Financial Regulation and the EU Staff Regulations. These are largely based on rules applicable to the European Institutions with little regard to the size of the JUs and nature of their activities. According to the interim evaluations of the JUs, this legal framework is not conducive to the efficient management of a small JU.

- Human resources. Due to the demanding legal and financial rules applying to the current JUs on the one hand, and the small overall size of the current JUs on the other hand, the structure of the JUs is one-sided when comparing administrative human resources with operational human resources: on average 50% of the JUs' staff is dedicated to work on administrative tasks. This percentage is high compared to the 22% ratio of the somewhat bigger European Agencies, also set up as union bodies.

- Recruitment rules. Under current regulation, due to the fact that JTI JUs are Union bodies, their staff recruitment rules follow the EU Staff Regulation. Accordingly, when planning recruitment, the grades and functions of new staff must be foreseen in the multi-annual staff policy plan and the annual budget. These require approval from the Governing Board and the European Commission as well as compliance with the multi-annual planning cycle starting at end of year N-2. Therefore, the recruitment procedures take a significant amount of time.

- Public procurement rules. The public procurement rules applied by the JU are similar to those used by the European Institutions. Moreover, the financial regulation does not permit a JU to conclude a Service Level Agreement (SLA) with another JU. Consequently, this prohibits the sharing of services between JUs in order to reduce costs (for instance, sharing the internal auditor function between two or more JUs).

- Delegation rights to the Executive Directors. Under the statutes governing the JU, the Executive Director is responsible for the day-to-day management of the JTI JU. While the financial regulation perhaps should give the authorising officer, i.e. the Executive Director, the overall responsibility for the financial management of the JU, their regulations require also the approval of the Governing Board - this delays decision-making. As a consequence, recurrent administrative decisions are brought up to the level of the Governing board, thus hampering its focus on strategic issues.

- The funding and participation rules applied to/by JTI JUs as compared to mainstream FP7 legal and financial framework result in different and often lower funding rates for participants in JTI JU managed projects than collaborative research, which compromises the accessibility (new rules have to be learned) and attractiveness (funding rates are lower) of the JTIs.

**Annex 10 - Executive Summary of the First Interim Evaluation of the FCH JU**

This review was undertaken by an Independent Expert Group (IEG) in support of the first interim review of the Fuel Cell and Hydrogen Joint Undertaking (FCH JU).

The primary outcome is that the IEG recommends that the FCH JU should be maintained and supported to implement its work as originally envisaged. Its potential role in a new phase of EC support for innovation following FP7 should be reviewed at a later date when outputs of its projects start to become available, as none are presently available to assess. However the IEG believes that there will be a need for continuation of this, or an equivalent, initiative. The IEG has also identified some areas where its operation could be improved, and makes a number of specific recommendations to this end.

The Joint Undertaking was created as a Community Body on 30 May 2008 and became autonomous in November 2010. Between May 2008 and November 2010 the Joint Undertaking was managed by the European Commission. This review was therefore undertaken in the first few months of autonomous operation and at a point when none of its projects were completed or at the stage of producing formal results or outcomes. Consequently its conclusions are based primarily upon evidence obtained from interviewing stakeholders about activity and performance of the Joint Undertaking and from the background material procured by the Commission.

The FCH JU has as its strategic objectives the positioning of Europe at the forefront of fuel cell and hydrogen technologies and enabling their market breakthrough by supporting RTD in a coordinated manner with a focus on market applications, and by encouraging increased public and private RTD investment in FCH in Member States and Associated Countries.

The review found that the overall technical objectives of the FCH JU as defined in the Multi-Annual Implementation Plan (MAIP) remain ambitious and competitive in comparison with efforts world-wide. It also concluded that the JU approach is generally regarded as a good means to enhance public-private activities in technology development and demonstration. The IEG is satisfied the FCH JU is perceived by participants as overall an improvement to the RD&D landscape, with strong stakeholder representation. In some areas it is also perceived as providing welcome stability for the R&D community given the cyclic nature of political interest and visibility: its presence is a reassuring "constant".

Some problems have been encountered:

- the set-up of the FCH JU took too long and especially the establishment of structures and activities in the first two years was not as efficient as would have been wished and expected. Steps should be taken to ensure similar problems are not repeated elsewhere in future, possibly in progressing initiatives such as European Industry Initiatives of the SET Plan (EII). The IEG endorses the recommendations of the Sherpa report[47] to streamline the legal framework and review the current 'Community body' status which would address the problem;

- the funding rates for FCH JU projects have proved variable from year to year but are always considerably lower than those of FP 7

- the Programme Office has insufficient technical resource for effective monitoring of the developing programme;

- cohesion and collaboration with Member States' related programmes is insufficient;

47 "Designing together the ideal house for public-private partnerships in European research", JTI Sherpa's Group. Final Report. January 2010

- the FCH JU lacks a formal communications plan and international engagement strategy.

Lessons learned here can and should be applied to any future Joint Technology Initiatives (JTIs) or EIIs. In particular the uncertainty of funding rates is a material failing and must be addressed.

A number of recommendations are made on changes to improve the operation and effectiveness of the FCH JU which are summarised below. Also it should be noted that a start has been made by the new permanent Executive Director on improving some of these aspects.

**Recommendation 1. Reinforce portfolio management**

The FCH JU needs to assume more responsibility for delivering its overall technical objectives and have an active management of its project portfolio through targeted call processes and on-going project review. The balance between application areas of the MAIP needs to be reviewed and methods implemented to ensure projects interact where appropriate.

To achieve its objective of placing Europe at the forefront of fuel cell and hydrogen technologies worldwide and at enabling the market breakthrough of these technologies, FCH JU should emphasise industrial leadership for large-scale projects.

The Scientific Committee (SC) has the potential to provide support to, and verification of, the above portfolio management approach, and opportunities to widen its present role to do this should be actively explored.

**Recommendation 2. Ensure high agility of operations and adaptability to changing competitive forces**

Over the last few years, technology development has brought fuel cells and its applications from research on how to make it work, to development on how to make it cheaper. The latter is to a large extent about cost reductions in systems and Balance of Plant (BOP) and will eventually lead to commercialisation and new products. To achieve its objectives, the FCH JU needs to maintain its focus on innovation and respond to emergent competing technologies.

The FCH JU must reinforce efforts to engage stakeholders from the complete value chain in addition to the manufacturers and researchers who represent the great majority of participants in the FCH JU.

**Recommendation 3. Improve visibility, communication and outreach**

International outreach and engagement should be a key role and responsibility for the FCH JU. There is an urgent need to increase FCH JU visibility, with a clear identity and mission.

The awareness of FCH JU initiatives and achievements also outside Europe should be increased and the FCH JU needs to establish what international engagement or participation should be sought to support the faster or cheaper achievement of its programme objectives.

**Recommendation 4. Improve collaboration and alignment with Member States**

It is clear that there is scope for improvement in the performance of the States Representatives Group (SRG) for the coordination with Member States' parallel activities. The SRG needs members connected to policy and programme management, not scientific experts, able to identify and to progress opportunities for alignment of national activities and those of the FCH JU.

**Recommendation 5. Ensure high efficiency of operations**

The current legal framework as a "Community body" is not well-suited to industry led public-private partnerships like JTIs and should be streamlined. The IEG supports the related recommendations of the JTI's Sherpa Group.

The time scale involved from publication of calls to negotiated call is around one year and should be improved upon. Currently the management structure is unbalanced in terms of administrative resources compared to project management, leaving the project management capability (just 25 % of the staff) under- resourced and probably insufficient to ensure delivery of objectives. A sufficiently skilled resource is needed for project monitoring and programme management (including portfolio management) greater than that presently in place.

Given the innovative nature of JUs it is recommended that an exchange of experience and advice between senior staff of all PPPs be organised, and that a dialogue is set up between FCH JU and other SET Plan initiatives of a similar nature to ensure exchange of best practice related to operation and implementation of objectives. Also, project monitoring and benchmarking of best practise should be introduced.

The full detailed recommendations are presented in the table below:

| **1. Reinforce portfolio management** | | |
|---|---|---|
| | ***Action:*** | ***Action for:*** |
| **1.1** | The MAIP should be thoroughly reviewed and updated where necessary before the production of the AIP for 2012. This exercise should be repeated no less than every 2 years to ensure the technical priorities remain valid in relation to results achieved and developments elsewhere. | *FCH JU GB* |
| **1.2** | The current project portfolio is evidently light on hydrogen production, storage and distribution and efforts should be made to increase activity. | *FCH JU GB, FCH JU SC* |
| **1.3** | Priorities and work on RCS should be led by industry. | *FCH JU Executive Director* |
| **1.4** | The structure and composition of the annual calls should explicitly support the objectives of the FCH JU, the interests of Europe, and competition in the market place through projects that clearly have industrial leadership. | *FCH JU GB, FCH JU Executive Director* |
| **1.5** | The EC must ensure appropriate support is provided for basic research in the FP. | *FCH JU GB, EC* |
| **2. Ensure high agility of operations and adaptability to changing competitive forces** | | |
| 2.1 | Actively involve all stakeholders of the value chain. | *FCH JU SRG, FCH JU Executive Director* |
| 2.2 | Establish an SME contact point at the Programme Office | *FCH JU Executive Director* |
| 2.3 | Explore opportunities for complementarity between FC electric cars and BEV in the market place | *FCH JU Executive Director, EC* |
| 2.4 | Commission a report on status, opportunities, and priorities for stationary fuel cells. | *FCH JU Executive Director* |
| **3 Improve visibility, communication and outreach** | | |
| 3.1 | Develop an effective communication strategy and web site. | *FCH JU GB, FCH JU Executive Director* |
| 3.2 | The communication plan should be aligned with the FCH-JU objectives and integrate both external and internal communication. | *FCH JU GB, FCH JU Executive Director* |
| 3.3 | Use SRG and SC actively in supporting FCH JU awareness. | *FCH JU GB, FCH JU Executive Director* |
| 3.4 | Develop strategy and priorities for international outreach, engagement and cooperation. | *FCH JU GB, EC* |
| 3.5 | Outputs from the FCH JU projects should be integrated into and used to support relevant EU policies. | *EC Policy Directorates* |

| | | |
|---|---|---|
| **4 Improve collaboration and alignment with member states** | | |
| 4.1 | Adjust SRG Rules of Procedure in order to better define the profile of the SRG representatives so that they are appropriately connected to political decision makers in their Member States. | *FCH JU GB* |
| 4.2 | To raise interest and attention from Member States involve representatives more proactively – candidate areas for this are developing project portfolio, communication and joint profiling events. | *FCH JU GB*<br>*FCH JU Executive Director* |
| 4.3 | Explore joint funding schemes between FCH JU and Member States. | *EC, FCH JU SRG* |
| **5 Ensure high efficiency of operations** | | |
| 5.1 | The current legal framework should be streamlined to fit the purposes of setting up and implementing JTIs. The staff rules must be tailored to the needs of a PPP of this scale and in particular the number of staff for project management must be raised. Review the possibility of sharing resource for required administrative functions between JUs to reduce costs to each and so allowing extra skilled project management resource to be included with no marginal cost increase. | *EC, FCH JU GB and FCH JU Executive director* |
| 5.2 | Plans should be developed and implemented for interaction and exchange between projects supported by the JU | *FCH JU Executive director* |
| 5.3 | Establish as soon as possible a high quality, robust system for project monitoring and assessment. | *FCH JU Executive director* |
| 5.4 | Undertake international benchmarking to establish best practice for project commissioning. | *FCH JU Executive director* |

**Annex 11 - Preferred Policy Option from stakeholder survey and public consultation**

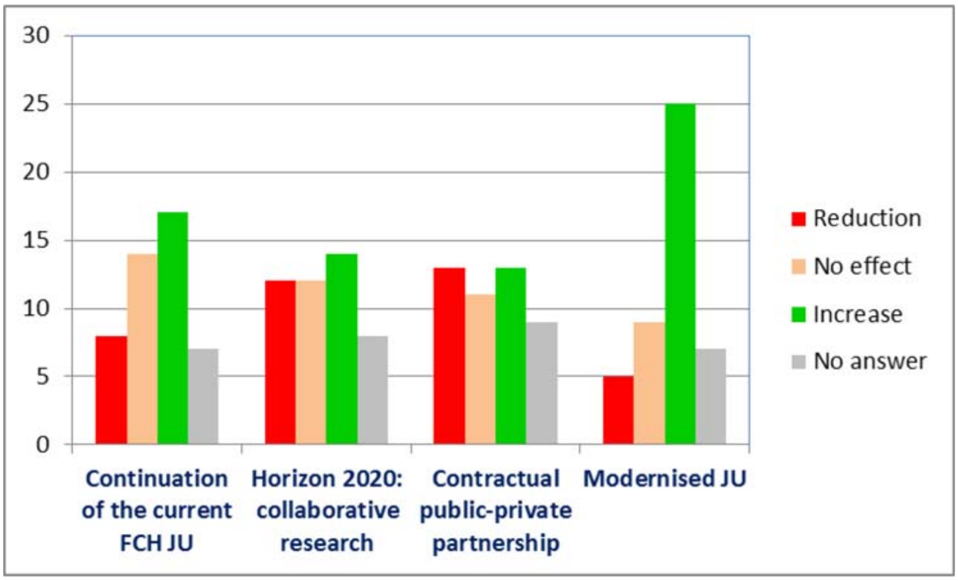



Figure 1. Industry Grouping (N=46) opinion on the impact of the four options on their research expenditures in the field of FCH over the period 2013 - 2020

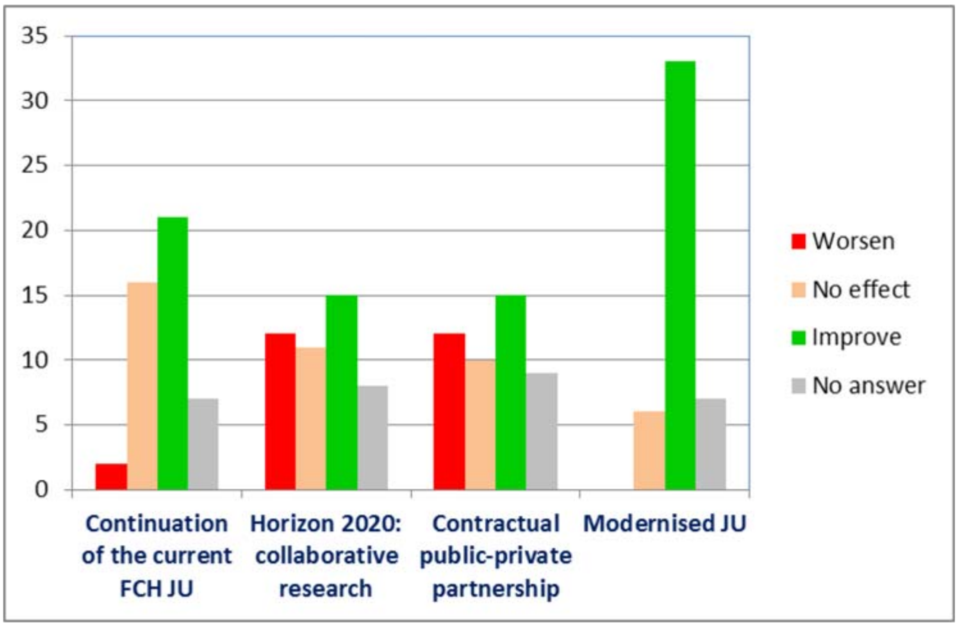



Figure 2. Industry Grouping (N=46) opinion on the impact of the policy options on research efficiency in the field of FCH over the period 2013 - 2020

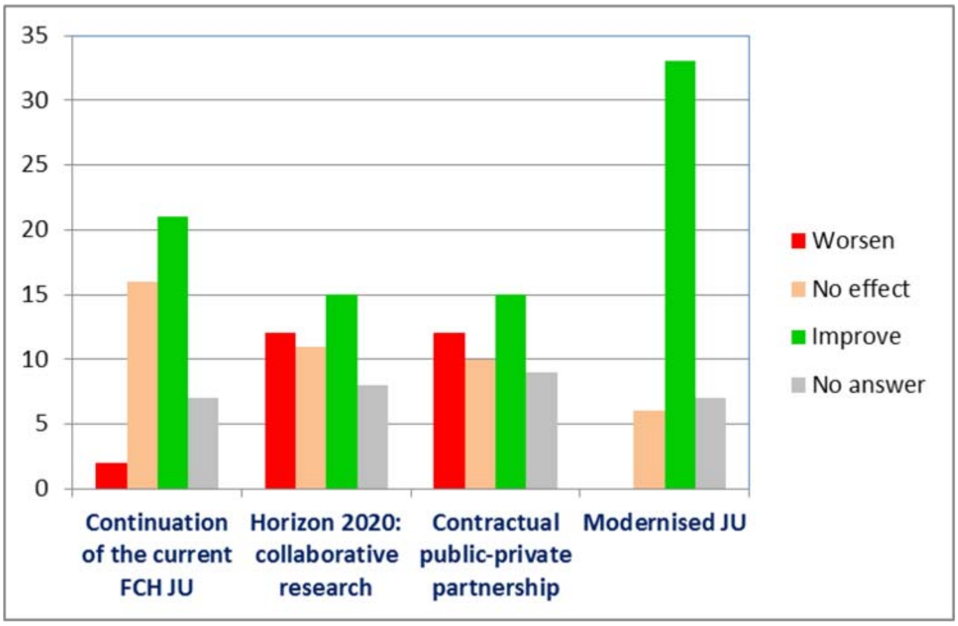



Figure 3. Industry Grouping (N=46) opinion on the impact of the policy options on the coordination of research between the FCH JU and MS programmes

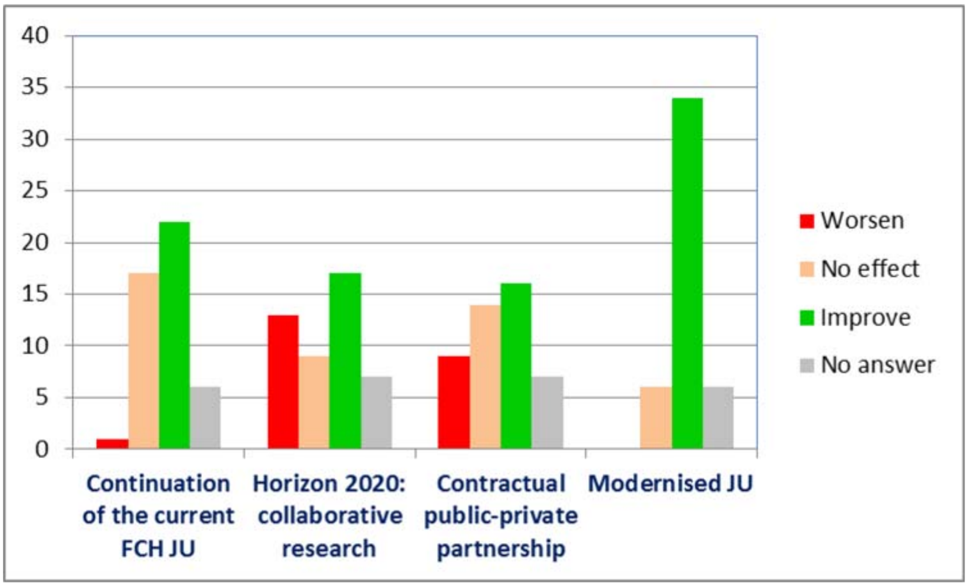



Figure 4. Industry Grouping (N=46) opinion on the impact of the policy options on product development in the field of FCH over the period 2013-2020

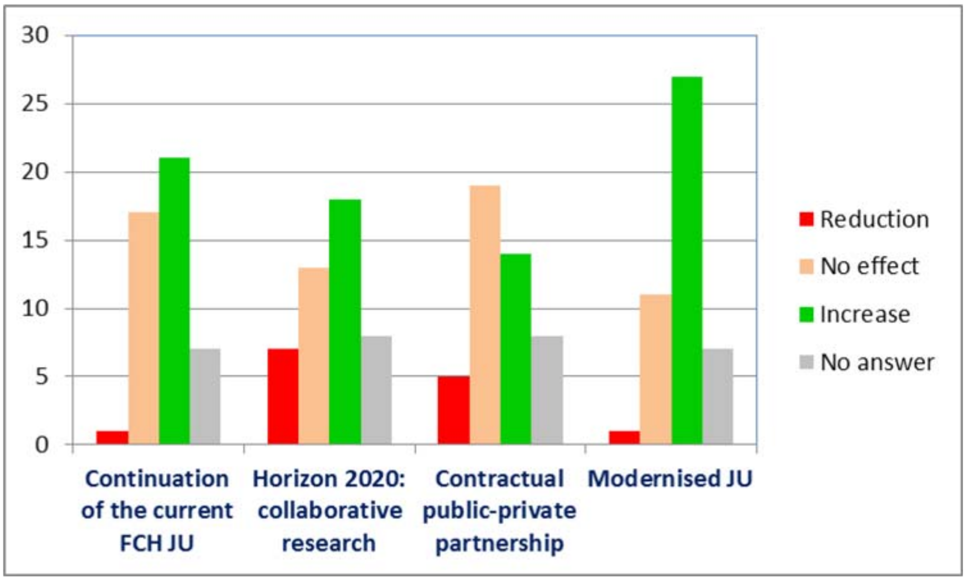
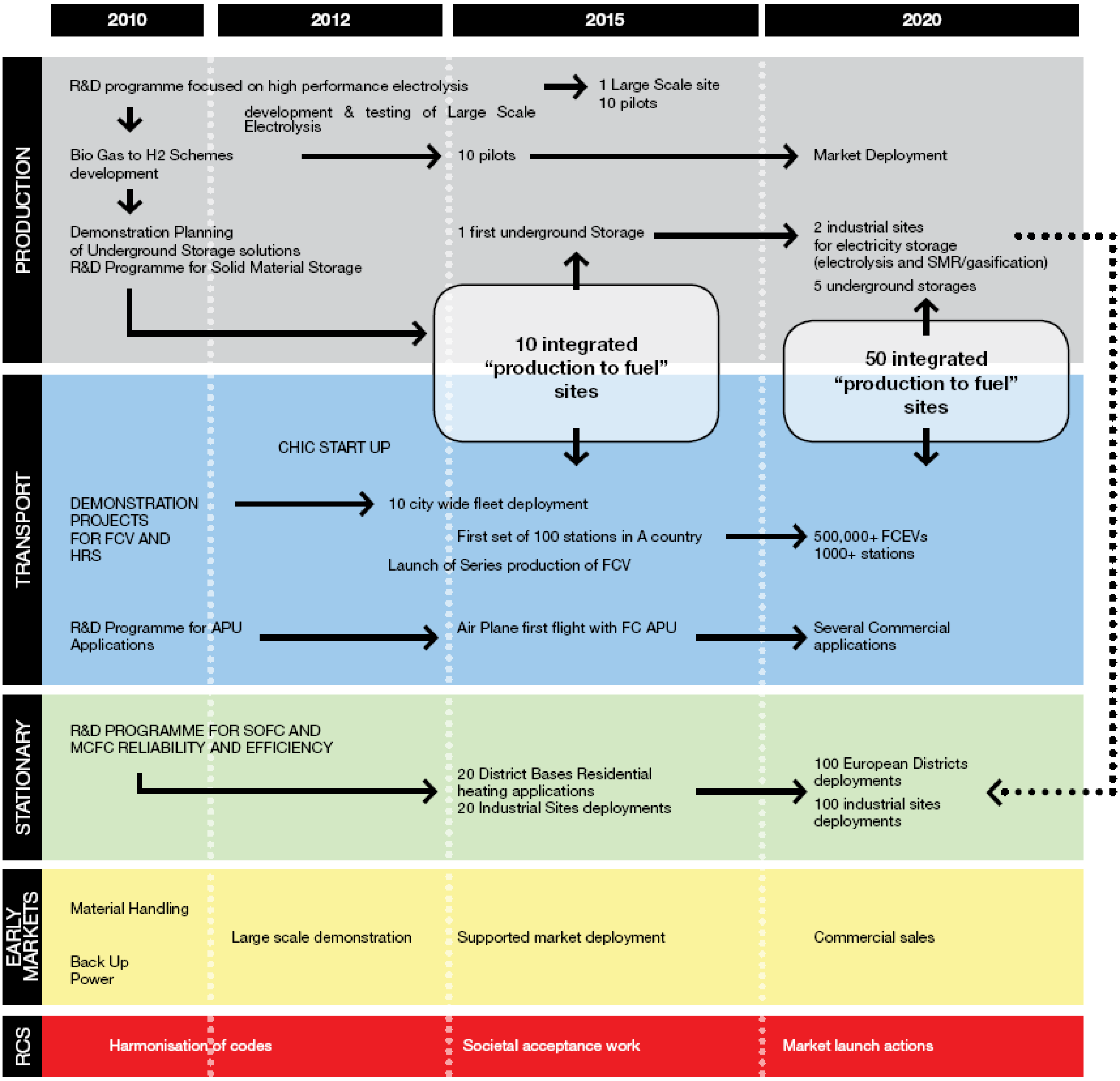



Figure 5. Industry Grouping (N=46) opinion on the impact of the policy options on staff in 2020


Figure 6. Favoured option from the public consultation

**Annex 12 - Technology development steps that will be followed until 2020 to bring the different applications to market.**




From: Financial and Technology Outlook for the European Fuel Cell and Hydrogen sector for 2014-2020[48]

[48] FCH JU Industry Grouping Financial and Technology Outlook 2014-2020, http://www.fch-ju.eu/page/publications