Fuel Cells and Hydrogen Joint Undertaking (FCH JU)

ANNUAL IMPLEMENTATION PLAN 2011

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1. Introduction: mission, objectives and challenges

This document establishes the fourth Annual Implementation Plan (AIP) of the Fuel Cell and Hydrogen Joint Undertaking (FCH JU), outlining the scope and details of its operational and horizontal activities for the year 2011, with a focus on research activities prioritised for the fourth Call for proposals, together with supportive actions required. It also describes the objectives of the FCH JU, the policy and global context, assessment criteria, technical targets and rationale for individual activities.

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

The European Strategic Energy Technology (SET) Plan has identified fuel cells and hydrogen among the technologies needed for Europe to achieve the targets for 2020 - 20% reduction in greenhouse gas emissions; 20% share of renewable energy sources in the energy mix; and 20% reduction in primary energy use – as well as to achieve the long-term vision for 2050[1] towards decarbonisation. This is in line with the Commission's Communication, "Energy for a Changing World – An Energy Policy for Europe"[2], the goals of the Lisbon Strategy and the European Council's Conclusion on a European Energy Strategy for Transport, 29 May 2007.

To implement these priorities and bring clean energy technologies to the market, a key element of the SET Plan's implementation strategy is to combine resources with the private sector, allowing industry to take the lead in identifying technology gaps that need to be addressed. The cooperation is structured through public-private partnerships, the European Industrial Initiatives. Among the first such initiatives, the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) was established by a Council Regulation of 30 May 2008[3] as a long-term public–private-partnership under the Seventh Framework Programme (FP7) of the European Community.

The FCH JU pools public and private resources, with activities co-financed by the Commission and the industry and research community partners. The founding members: the Union, represented by the European Commission, and the *European Fuel Cell and Hydrogen Joint Technology Initiative Industry Grouping* (hereinafter referred to as "the IG"), share the running costs of the JU, with an additional contribution from the third member, *the New European Research Grouping on Fuel Cells and Hydrogen*, N.ERGHY (hereinafter referred to as "the RG").The planning of the agenda for research, technological development and demonstration (RTD) is led by industry to ensure that it is focused at the objective of commercialisation.

The FCH JU's first call for proposals, with indicative Community funding of €28.1M[4], was finalised in December 2009 with the conclusion of contracts with 16 project consortia[5]. The

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[1] COM(2007) 723 final
[2] COM(2007) 1 final
[3] Council Regulation (EC) No 521/2008 of 30 May 2008 setting up the Fuel Cells and Hydrogen Joint Undertaking for the implementation of the Joint Technology Initiative on Fuel Cells and Hydrogen, OJ L 153/1, 12.6.2008, p.1.
[4] €28,771,590 including European Free Trade Area (EFTA) contributions 2.4% from countries associated to the 7th Framework Programme.
[5] For details of the projects funded in the first call, please see http://www.fch-ju.eu/page/projects

second call, with an indicative Community funding of €71.3M[6], finalised in December 2010 with the conclusion of contracts with 28 project consortia. The third call, with an indicative Community funding of 89.1M€[7], entered into the negotiation stage in March 2011.

The current AIP outlines the FCH JU's work plan for 2011, in line with the programme priorities set out in the Multi-Annual Implementation Plan (MAIP) adopted by the Governing Board on 15 May 2009[8]. In particular, the AIP establishes the list of topics and detailed topic descriptions for the Call for Proposals to be published in 2011.

It is important to note that, during the year 2010, the final pieces were put in place for the autonomous execution of the activities and, accordingly, the FCH JU became an autonomous legal entity on 15 November 2010. The administrative framework of the FCH JU was also completed in 2010 with the adoption of the management and internal control systems and the implementation of the accounting system that became operational on 17 November. With these developments, the FCH JU is fully equipped to run its operations as an autonomous entity. A systematic risk management process integrated in the FCH JU's annual plan has been recently concluded. Two critical risks have been identified, namely: (1) the impact that the current funding rules and matching requirements have on the attractiveness of the JU's programme and (2) the problems experienced with the IT tools which could impact the operational performance of the JU. Actions have been defined and are ongoing to mitigate both risks. In particular, (1) the Governing Board requested the Commission on June 2010 to initiate the process for changing the relevant articles in the Regulation in order to improve the funding levels in the coming years and (2) the recruitment of the IT assistant, a timely reporting and monitoring of IT issues, a root-cause analysis of the problems and a close follow up of Service Level Agreements, should reduce significantly the probability of similar problems reoccurring in the future.

[6] €72,970,240 including European Free Trade Area (EFTA) contributions 2.4% from countries associated to the 7th Framework Programme.

[7] The funding includes the FCH JU's own budget only. The final total funding for projects is expected to be increased by European Free Trade Area (EFTA) contributions from countries associated to the 7th Framework Programme of up to 2.38%.

[8] The Multi-Annual Implementation Plan can be consulted at http://www.fch-ju.eu/page/documents

2. FCH JU Governance

The FCH JU is composed of two executive bodies: the Governing Board and the Executive Director. In addition there are three advisory bodies, the Scientific Committee, the FCH States Representatives Group and the Stakeholders' General Assembly.

2.1 Governing Board

The Governing Board shall have the overall responsibility for the operations of the FCH JU and shall oversee the implementation of its activities in accordance with Article 5 of the Statutes. The IG has 6 seats, the EC 5 seats and the RG 1 seat respectively.

The Governing Board is planning to hold three Board meetings during 2011. The key activities are listed below:

Key activities in 2011 - timetable	
Adopt the budget amendment for the financial year 2011 reducing the EC contribution for operational costs	Q1
Adopt the lists to start negotiations for call 2010, including reserve lists, lists of proposals which failed thresholds and ineligible proposals	Q1
Adopt the correction factor 0.72 to be applied for call 2010 to the funding rates for the direct costs	Q1
Adopt the AIP 2011	Q2
Adopt the External Communication Strategy of the FCH JU	Q2
Approve the final account 2010	Q2-3
Approve the 2012 budget	Q4
Adopt the AIP 2012	Q4

2.2 Executive Director and the Programme Office

The Executive Director is the legal representative of the FCH JU, and shall be the chief executive for the day-to-day management in accordance with the decisions of the Governing Board in line with Article 6 of the Statutes. The Executive Director will be supported by the staff of the Programme Office.

Mr Bert De Colvenaer, following the GB decision taken on 15 June 2010, was appointed Executive Director and took up duty in September 2010.

He is assisted by the Programme Office, which is expected to have 20 of its own staff recruited by the second quarter of 2011.

The activities of the Programme Office include the preparation of all the decisions and activities of the Governing Board and the advisory bodies described in this chapter and the day-to-day execution of the FCH JU programme as described in Chapters 4 and 5 below.

2.3 Scientific Committee

The Scientific Committee is an advisory body to the Governing Board. It shall conduct its activities in close liaison and with the support of the Programme Office.

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

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

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

(b) advise on the scientific achievements described in the Annual Activity Report;

(c) advise on the composition of the peer review committees.

Nine members were appointed to the Scientific Committee in the first half of 2009[9]. There have been no changes to the membership since.

The Scientific Committee will hold two to three meetings in 2011. Its main activities will be:

Key activities in 2011 - timetable	
Provide input on the scientific priorities of the AIP 2011	Q1
Provide input to the revision of the MAIP	Q2
Provide input on the scientific priorities of the AIP 2012	Q3-4

2.4 FCH States Representatives Group

The FCH States Representatives Group (SRG) shall consist of one representative of each Member State and of each country associated to the 7th Framework programme.

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

(a) programme progress in the FCH JU;

(b) compliance and respect of targets;

(c) updating of strategic orientation;

(d) links to Framework Programme Collaborative Research;

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

(f) involvement of SMEs.

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

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

[9] For the list of members, see http://www.fch-ju.eu/page/scientific-committee

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

The FCH States Representatives Group may issue, on its own initiative, recommendations to the FCH JU on technical, managerial and financial matters, in particular when these affect national interests. The FCH JU shall inform the FCH States Representatives Group of the follow up it has given to such recommendations.

The States Representatives Group will hold two to three meetings in 2011. Its main activities will be:

Key activities in 2011 - timetable	
Consultation of the SRG on the topics for Call for Proposals 2011	Q1
Consultation of the SRG on the revision of the MAIP	Q2
Consultation of the SRG on the topics for the Call for Proposals 2012	Q3-4
Feedback on Stakeholders General Assembly	Q4

2.5 Stakeholders' General Assembly

The Stakeholders' General Assembly (SGA) shall have an advisory role to the FCH JU. It shall be open to all public and private stakeholders, international interest groups from Member States, Associated Countries as well as from Third Countries.

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

The Stakeholders' General Assembly is an important communication channel to ensure transparency and openness of the RTD activities with its stakeholders. It shall be convened once a year.

The fourth Stakeholders' General Assembly is scheduled to take place in Brussels on 22-23 November 2011. The emphasis of the agenda is foreseen to be on FCH JU progress and projects as well as wider policy and market strategies for the commercialisation of fuel cell and hydrogen technologies.

Key activities in 2011 - timetable	
The 4th SGA meeting 22-23 November 2011	Q4

3. Operational Activities: Objectives and Indicators

3.1 Strategic Objectives

In carrying out a programme of RTD activities in the field of hydrogen and fuel cells, the following constitute the main objectives of the FCH JU:

- Aim at placing Europe at the forefront of fuel cell and hydrogen technologies worldwide and enabling the market breakthrough of fuel cell and hydrogen technologies, thereby allowing commercial market forces to drive the substantial potential public benefits;
- Support RTD in the Member States and countries associated with the Seventh Framework Programme in a coordinated manner in order to avoid market failure, focus on developing market applications and facilitate additional industrial efforts towards a rapid development of fuel cell and hydrogen technologies;
- Support the implementation of the RTD priorities of the Multi-Annual Implementation Plan of the FCH JU, notably by awarding grants following competitive calls for proposals;
- Undertake supporting actions where appropriate through calls to tender;
- Aim to encourage increased public and private RTD investment in fuel cells and hydrogen technologies in the Member States and Associated countries;
- Ensure the coordination and efficient management of funds. Management will be guided by the principles of transparency and openness, competitiveness and excellence, inclusiveness and close cooperation among stakeholders in order to achieve the best possible benefit for Europe. RTD activities will respect the fundamental and ethical principles applicable to the Seventh Framework Programme.

The more specific objectives for 2011 relate to ongoing and new projects funded by the FCH JU and are outlined in the following sections.

3.2 Projects from Previous Calls

A total of 16 contracts from the call 2008 were signed with project consortia. Of those, one project (NextHyLights) ended on December 31, 2010, while two others (Autostack and PreparH2) will finish during the year 2011. The rest are ongoing and will reach the midterm point in June 2011. It is expected that midterm reviews will be conducted in Q3 2011.

A total of 28 contracts from the call 2009 were signed with project consortia. Two projects, HyGuide and H2FC-LCA, will be completed during 2011.

Projects from the call 2010 will be negotiated during Q2-Q3 2011. Grant Agreements resulting from the successful conclusions of negotiations are expected to be signed towards the end of Q3 2011.

A review day of the finished and running projects is foreseen close to the Stakeholders General Assembly. The presentations will allow publicly assessing the progress of the programme towards its objectives.

3.3 The 2011 Call for Proposals

The Annual Implementation Plan (AIP) is the result of a joint effort by the major stakeholders - namely the IG, the RG and the European Commission. It represents a set of prioritised actions, consistent with the long-term objectives of the FCH JU, which are implemented on an annual basis in order to facilitate the rapid deployment of fuel cell and hydrogen technologies, and to achieve the overall objectives of the FCH JU.

Within the framework of the available annual budget, the actions have been chosen based on their potential contribution to achieving Europe's policy objectives, i.e. the Commission's targets for green house gas reductions, energy security and competitiveness. They include in a balanced way research, technological development, demonstration and cross-cutting activities, including Regulations, Codes & Standards (RCS).

The overall programme of the FCH JU is divided into four major horizontal application areas (AA): Transportation & Refuelling Infrastructure; Hydrogen Production, Storage & Distribution; Stationary Power Generation & CHP; and Early Markets. Cross-cutting activities have also been established as a fifth area in order to make their relevance more visible. The programme structure reflects the RTD cycle from long-term and breakthrough-oriented basic research to demonstration and support activities. Pre-normative research is also included at project level. The emphasis given to different action categories in different application areas reflects the industry and research partners' assessment of the state of technological maturity of the applications.

The main objectives and activities of the different AAs are laid out next.

3.3.1 Transportation & Refuelling Infrastructure

For the transportation applications of fuel cell and hydrogen technology, paving the way to market introduction of fuel cell vehicles is of highest priority as the reduction of energy consumption and greenhouse gas emissions expected from these vehicles is significantly higher than any other application of fuel cell and hydrogen technology in the transport sector. Thus, a significant part is the large-scale demonstration of FCEVs including the buildup of the necessary refuelling infrastructure. As a result of the FCH-JU project NextHyLights, the budget foreseen for vehicle demonstration in the call 2011 is limited to 7 Mio Euro per project, with a maximum of two projects.

Not only the vehicle technology but also technologies for the refuelling stations are of high relevance for the success of fuel cell technology in drive applications. Consequently one topic in the call is dealing with the improvement of 700 bar refuelling concepts and technologies, while another deals with pre-normative research on the filling process. The aircraft sector is also facing more and more the need the reduce GHG emissions. Introduction of fuel cell system for the main power of aircrafts are unlikely in the next decades, but FC APUs can play an important role. For this reason, the call also includes the topic FC-APU for aircrafts.

Fuel cell systems still need further research and development on competitive and reliable components. Quite a number of topics address important components, such as peripheral components (e.g. air supply subsystems), membranes, membrane electrode assemblies and bipolar plates. Characterisation and diagnostic techniques as well as modelling and simulation accomplish the work on the components. Degradation of fuel cells is also an important topic in this call.

3.3.2 Hydrogen Production & Distribution

This application area aims to develop a portfolio of sustainable hydrogen production, storage and distribution processes which can meet an increasing share of the hydrogen demand for energy applications from carbon-free or lean energy sources. To achieve this, the various sustainable hydrogen production and supply chains must be demonstrated and ready for commercialisation by 2013.

The application area Hydrogen Production and Distribution will focus for the first time on demonstration of production facilities, based on electricity or biogas as primary energy source, which should provide an effective coupling to the hydrogen delivery infrastructure. The demonstration projects of renewable hydrogen production will prepare the ground for future large investments in synergy with the AA on "Transportation & Refuelling Infrastructure".

R&D in innovative hydrogen production and supply chains from renewable energy sources (e.g. low and high temperature electrolysis and direct production of hydrogen from biomass, including technologies such as enzymes for fermentation, or solar energy) are another priority topic for this application area. Improved solid state and underground storage as well as pre-normative research will be supported in order to complement renewable production pathways and help establish a robust supply chain for hydrogen. The efficiency of existing hydrogen production processes shall also be improved, contributing directly to further energy savings in Europe.

A topic devoted to low cost PEM electrolysis will further the development of distributed renewable electricity generation. Finally, a topic on pre-normative research on degradation phenomena of components exposed to hydrogen and a topic for enabling certified measurement of hydrogen delivery to vehicles are proposed.

For the purpose of facilitating the process of ranking lists, in case of equal scores of proposals during the evaluation, R&D projects should be favoured over demonstration projects.

3.3.3 Stationary Power Generation & Combined Heat and Power (CHP)

The research objectives of this application area are designed to reflect the main needs of the three principal fuel cell technologies, i.e. MCFC, PEMFC and SOFC. MCFC and PEMFC technologies are generally speaking further advanced than SOFC. Thus a diverse set of actions is required to cover the different RTD needs.

The programme aims to achieve the principal technical and economic requirements needed to compete with existing energy conversion technologies, such as high electrical efficiencies of 45%+ for power units and of 80%+ for CHP units, combined with lower emissions and use of non-hydrocarbon fuels. Focused efforts are required to address lifetime requirements of 40,000 hours for cell and stack, as well as commercial target costs, depending on the type of application.

Basic research activities will be directed to new generation stack and cell designs, while applied research activities are directed towards developing components and sub-systems with improved performance, durability and cost for all three technologies in order to achieve system application readiness.

Demonstration activities target proof-of concept, technology validation or market capacity build up, depending upon technological maturity. Generally, they will focus initially upon MCFC and PEMFC near-ready units, whilst SOFC technologies are more likely to be ready for validation and demonstration at later dates. Field demonstration activities are split into small (residential and commercial applications) and large (distributed generation or other industrial or commercial applications) scale.

3.3.4 Early Markets

This Application Area is aimed at developing and demonstrating a range of fuel cell-based products capable of entering the market in the near term, which is important for achieving both public awareness and providing commercial success stories.

The sectors addressed are:

- *Transport:* mainly off-road transport with an emphasis on industrial and material handling vehicles (including their supporting fuelling infrastructure)
- *Stationary:* with an emphasis on Back-up Power (BUP) and Uninterruptible Power Systems (UPS) for telecommunications and other sectors (also including their supporting fuelling infrastructure)
- *Portable:* covering a wide range of possible products such as battery recharging (e.g. for industrial power tools); for emergency and remote power; and for recreational, educational, and personal portable power applications

In this call there is coverage of both demonstration activities for more mature fuel cell systems and R&D for enhancing systems to meet operational and cost requirements or to reduce the time to demonstration and deployment.

For the demonstration topics, the emphasis is on real-world demonstration and deployment of material handling and BUP or/and UPS products, with improved technology maturity and cost of ownership targets for these applications. These demonstrations are intended to attract additional industrial engagement and extend the range and type of products and applications in the market, as well as to deliver valuable experience and data from extended fleet operations, establish supporting infrastructure elements and increase customer awareness and user acceptance. The demonstrations projects are intended to be at a scale to achieve cost reductions through economies of scale and thereby addressing cost barriers for future commercial deployment. It is also intended that where synergies with other AAs (Stationary, Transport) exist they should be realised.

Additional research and development efforts are necessary for 1-10kW fuel cell systems, portable systems and Balance of Plant for small portable systems to achieve focused technology improvements against operational and performance targets, and against future cost competitiveness objectives, and in order to reduce the time to demonstration deployment and market readiness.

There is a general objective that public awareness and understanding of the technologies should be strengthened, especially as concerns code and standards and safety matters amongst early adopters. Recognition of these areas will be expected in all project proposals. The portable sector offers opportunities for greater public awareness (due to the broader outreach of the applications, compared to material handling and stationary installations) and will thus help pave the way for a widespread acceptance of the technology, with fuel cells becoming general consumer items.

Finally, as early markets represent niche opportunities for SMEs, the involvement of SMEs is encouraged in order to realise product specific commercialisation opportunities or for better integration of SMEs in future industrial supply chains.

3.3.5 Cross-cutting Activities

These activities will serve the objectives of the FCH JU in a variety of ways, in particular to ensure that non-technical barriers to the deployment of these technologies are properly addressed. They will include:

1. Studies on assessment of benefits on the use of hydrogen as an energy storage medium, as well as on advanced financing instruments to achieve acceleration of market introduction of hydrogen and fuel cell technologies
2. Educational aspects, with the development of hydrogen safety training for first responders, considered critical for the successful introduction of market-ready products
3. Development of harmonised testing protocols for PEM stacks, in order to achieve a set of testing procedures that provide a uniform look at their characteristics

3.3.6 Collaboration with JRC

The Framework Agreement between the FCH JU and JRC[10] identifies a number of activities that JRC can provide to the FCH-JU, either upon request of a project consortium, or by the FCH-JU Programme Office. In the latter case, JRC involvement may be identified in the formulation of the call topic, or be called upon during the negotiation phase of an approved project.

3.3.7 List of topics

In line with the political and technical objectives outlined above, a total of 36 topics have been prioritised for the AIP 2011 and the fourth call for proposals of the FCH JU. The table below describes specific topics selected for the fourth call, together with their rationales. For a detailed description of the topics, see Section 3.6 of this document. Please note that when submitting a proposal the topic reference to be used in the submittal forms is the one identified in this Section 3.6.

[10] The Framework Agreement is available at: http://www.fch-ju.eu/page/documents

No.	Topic	Scope	Indicative FCH JU Funding Million €
Transportation & Refuelling Infrastructure			**36.0**
1	Large-scale demonstration of road vehicles and refuelling infrastructure IV	Demonstration of second generation fuel cell hybrid buses for public transportation, passenger cars and appropriate refuelling infrastructure with improved durability, robustness, reliability and efficiency. Activities should expand on existing hydrogen infrastructure. The aim is to provide extended operating experience, and prove technological readiness. Demonstration trials are supported by activities on public awareness, on technological and environmental assessment, on safety and certification requirements.	
2	In-situ characterization and diagnostic techniques for optimisation of water management and state of health determination of PEMFC	Development of advanced *in-situ* diagnostic techniques for improving the understanding of the level of degradation in PEM fuel cells by concentrating on the water management aspect, primarily during variable loads such as those found in transportation applications. The objective is to improve durability and increase reliability in PEM fuel cells.	
3	Improvement of PEMFC performance and durability through multi-scale modelling and numerical simulation	Development of multi-scale modelling and numerical simulation tools for increasing the performance and durability of PEM fuel cells. These computer-based tools are to be validated through experimental work as well.	
4	Periphery – FC-System Components	Advanced research and development for next generation balance of plant components for PEM fuel cells in transportation applications. The work will focus on air compressors, anode recirculation modules, air humidifiers and air processing units and will improve lifetime and reliability of these systems.	
5	Next generation European MEAs for transportation applications	Development of catalysts for PEM fuel cells- to further reduce the use of platinum in membrane electrode assemblies (MEAs), increase catalyst performance and electro-chemical stability; development of novel materials for gas diffusion layers (GDLs). Testing of the MEAs. The overall aim is to produce MEAs with significant specific cost reduction (i.e. cost/power).	
6	Investigation of degradation phenomena	Research and development on critical system operating parameters and conditions to establish a solid methodology and develop tools for safe life-time assessments and help improve system and vehicle operating strategies.	
7	Research & development on Bipolar Plates	Research and development of cost effective bipolar plate manufacturing technologies including corrosion resistant coatings for stainless steel, demonstration of processability of steel/coating combination in complex configurations, as well as adequate stacking capabilities and long-term stability under fuel cell conditions (anode and cathode side conditions).	
8	Research & Development of 700 bar refuelling concepts & technologies	Research and development of new technologies that have the potential to reduce the cost of 700 bar refuelling, including new or improved retail equipment, new station concepts and distribution concepts that improve chain efficiency and cost.	

No.	Topic	Scope	Indicative FCH JU Funding Million €
9	Fuel cell systems for airborne application	The overall objective is to design, develop and flight test an aircraft related fuel cell system against flight / application specific requirements. Hydrogen based fuel cell systems are expected to facilitate the early introduction of PEM fuel cell system applications in the near-term and early examples derived from automotive system designs have already been flight or ground tested.	
10	Pre-normative research on fast refuelling	Identification, definition, and evaluation of approaches for optimised fuelling procedures, with regards to required pre-cooling and/or allowable filling speed. Evaluation of the influence of tank construction on the maximum allowable filling speed. This topic is expected to contribute to further refinement of the current standard, SAE J2601.	
Hydrogen Production & Distribution			**16.0**
11	Demonstration of MW capacity hydrogen production and storage for balancing the grid and supply to a hydrogen refuelling station	Demonstration of the technological readiness and performance of production and storage of hydrogen from electricity available on the grid, with subsequent supply to a vehicle hydrogen refuelling station (retail, public transport, or fleets). Definition of an optimised energy storage system as a function of grid balancing constraints, as reflected by the spot purchase price, and local hydrogen fuel needs.	
12	Demonstration of hydrogen production from biogas for supply to a hydrogen refuelling station	Demonstration of the technological readiness and performance of production and storage of hydrogen from biogas with subsequent supply to a nearby vehicle fuelling stations (retail, public transport, or fleets). Study of relevant regulatory aspects associated with use of renewable certificates, access to spot purchase prices, as well as RCS relative to hydrogen production and stationary storage.	
13	Biomass-to-hydrogen (BTH) thermal conversion process	Development and scale-up activities on materials and reactor design in order to obtain a continuous process for hydrogen production from biomass. The final target is to demonstrate the technical and economical viability of the global process.	
14	Novel H_2 storage materials for stationary and portable applications	Development of optimised hydrogen storage materials for fuel cell applications. The project focuses on using existing, state-of-the-art hydrogen storage materials of any kind and to improve their performance characteristics in order to reach market potential.	
15	New generation of high temperature electrolyser	Development activities of high-temperature electrolysis, with focus on cells and stacks. The objective is to couple high-temperature electrolysers with renewable solar and nuclear energy systems, with substantial improvement of energy-efficiency.	
16	Low-temperature H_2 production processes	Development of efficient chemical or biological systems converting solar energy into chemical energy for water splitting. Efficient, easy to handle chemical or biological systems shall be developed and the low temperature hydrogen production shall be demonstrated in small scale reactors.	

No.	Topic	Scope	Indicative FCH JU Funding Million €
17	Innovative Materials and Components for PEM electrolysers	Development activities on low cost, low temperature electrolysers based on PEM technologies, including prototyping and testing; demonstration of the application and production readiness.	
18	Pre-normative research on design and testing requirements for metallic components exposed to H2-enhanced fatigue	Pre-normative research for development of optimised design requirements, design testing, and field inspection to ensure fitness for service of metallic sub-systems subject to cyclic fatigue in hydrogen service.	
19	Measurement of the quantity of hydrogen delivered to a vehicle	Development and testing of measurement system of the quantity transferred having a level of accuracy acceptable by weights and measure authorities. The work will also address obtaining acceptance by regulatory bodies.	
Stationary Power Generation & CHP			**38.0**
20	Next generation stack and cell design	Research on novel architectures for cell and stack design to provide step change improvements over existing technology in terms of performance, endurance, robustness and cost targets for relevant applications. Efficiency, cost, reliability (and power density) are main drivers. The call is open to all solutions or operating ranges, geometries or materials. The project proposals should be small and focused, leading to a proof of concept.	
21	Advanced control for stationary power applications	Development activities on control and diagnostic tools for a) reliable degradation and lifetime prediction of cells and stacks; b) robust control and operation of complete fuel cell systems. Open to all fuel cell technologies.	
22	Component improvement for stationary power applications	Development activities to improve a) The performance of individual components of fuel cell systems (e.g. fuel cell units, reformer, heat exchangers, fuel management and power electronics); b) The understanding and optimization of interaction between BoP components and mature stacks. The objective is to meet relevant performance targets, including durability and cost. Open to all fuel cell technologies.	
23	Proof-of-concept fuel cell systems	Development of proof-of- concept prototype fuel cell systems for any stationary application, potential feature and technology. The aim is to demonstrate feasibility of proposed systems. The aim is to show interaction between the PoC FC systems with other devices required for delivering power, heat and cooling to end users.	
24	Validation of integrated fuel cell system readiness	Validation of fully integrated stationary fuel cell systems. Projects need to provide technical solutions for one among the main stationary application categories (domestic, commercial and industrial including CCS), including identification of mass-production route at a defined quality. They shall identify relevant technology approaches to specific applications and markets.	

No.	Topic	Scope	Indicative FCH JU Funding Million €
25	Field demonstration of large stationary fuel cell systems for distributed generation and other relevant commercial or industrial applications	Demonstration of FC-based integrated generator systems in real application environment which includes interfaces with the infrastructure for power, heat, CCS, renewable sources and fuel/oxidant processing as necessary.	
26	Field demonstration of small stationary fuel cell systems for residential and commercial applications	Demonstration of FC-based integrated generator systems in real application environment which includes interfaces with the infrastructure for power, heat, CCS, renewable sources and fuel/oxidant processing as necessary.	
27	Pre-normative research on power grid integration and management of fuel cells for small residential, commercial and industrial applications	Pre-normative research on power grid integration and management of fuel cells for residential CHP, commercial and industrial applications. Through review of previous RCS activities, the projects shall produce proposals and recommendations on background procedures and methodologies for RCS as well as for further development of RCS. Dissemination to research and industry shall be included.	
Early Markets			**15.0**
28	Demonstration of fuel cell-powered Material Handling vehicles including infrastructure	Demonstration of technical and economic viability of fuel cell-powered material handling vehicles in industrial use (e.g. forklifts, pallet trucks), including the related hydrogen refuelling infrastructure. The aim is to address critical application requirements with regard to sustainability, efficiency and logistic effort. Demonstration trials are supported by activities on dissemination and certification requirements.	
29	Demonstration of application readiness of Back-Up Power and Uninterruptible Power Systems	Demonstration of industrial application readiness with respect to cost-competitiveness, lifetime, logistics and environmental performance of fuel cell and hydrogen systems for back-up power and uninterruptible power supplies, including hydrogen supply solution.	
30	Research and development of 1-10kW fuel cell systems and hydrogen supply for early market applications	Development of new generation high performance, durable and cost-effective fuel cell system in the 1-10kW power range for early markets such as back-up power, UPS and material handling equipment. Full concepts across the entire value chain are pursued addressing both fuel cell system and hydrogen cost.	
31	Research, development and demonstration of new portable Fuel Cell systems	Research and development to develop novel portable and micro Fuel Cell Solutions (low and high temperature) targeted to meet specific application requirements.	
32	Research and development of Balance of Plant items for small portable and other fuel cell devices	Development of balance of plant components for small fuel cells (10- 500 W) in order to achieve the required power density, prove the capability to operate with different fuels and meet target cost.	
Cross-cutting Issues			**4.0**

No.	Topic	Scope	Indicative FCH JU Funding Million €
33	Assessment of benefits of H_2 for energy storage and integration in energy markets	Study to assess the potential use of hydrogen as an energy storage medium in energy markets. The topic looks at the potential integration of hydrogen with renewable energy sources and will establish the conditions under which this option is advantageous.	
34	Study of Financing Options to accelerate commercialisation of hydrogen and fuel cell technologies	Assessment of a broad variety of financing options for rapid uptake of the FCH technology. Development of innovative and advanced financing instruments and/or organisations. Discussion with major stakeholders and development of implementation plans.	
35	First responder educational and practical hydrogen safety training	Support for the successful implementation of hydrogen and fuel cell demonstration projects and market transformation by providing educational and practical hydrogen safety training to fire services and site operators, who must know how to handle potential incidents.	
36	Development of EU-wide uniform performance test schemes for PEM fuel cell stacks	Development of accepted testing protocols for PEM fuel cell stacks, in order to harmonise their assessment of performance characteristics.	
		Total indicative FCH JU Funding	**109.0**

3.4 Indicators

Fuel Cells and Hydrogen Joint Undertaking – RTD activities					
SPECIFIC OBJECTIVES		Result indicators			
		Indicator	Target	Latest known results	
1	**To address technological and non-technological barriers to commercialisation of FCH technologies as defined in the MAIP**	Coverage of topics called for	100% by 2013	78%[11]	
		Percentage of proposals which successfully address the criteria of scientific and/or technological excellence[12]	70% by 2013	74%[13]	
		Percentage of projects which have fully achieved their objectives and technical goals and have even exceeded expectations	60%[14] by 2013	Data not yet available [15]	
2	**To promote the use and dissemination of research results with a view specifically to commercialising FCH technologies**	Percentage of proposals which successfully addressed the criterion of dissemination and use of project results[16]	70% by 2013	83%[17]	
		Percentage of projects showing evidence that they will produce significant scientific, technical, commercial, social or environmental impacts	60%[18] by 2013	Data not yet available	
		Percentage of industrial participation in the projects of which SMEs	50% of industrial participation by 2013	48.8%[19]	
			15% of SMEs participation by 2013[20]	23.6%[21]	
		Percentage of projects which generate one or more patent applications	30% by 2013	Data not yet available	
		Percentage of projects with publications in peer reviewed journals	55% by 2013	Data not yet available	

[11] Based on the evaluation results of the previous three Calls for Proposals.
[12] Based on the Consensus report for projects established by the evaluators to rank the proposals. The scoring used for this indicator is very good to excellent.
[13] Based on the evaluation results of the three previous Calls for Proposals.
[14] On finished projects. (not all projects will be finished by 2013)
[15] No FCH JU projects have been finished at the time of the publication of the AIP 2010.
[16] Based on the Consensus report for research projects established by the evaluators to rank the proposals. The scoring used for this indicator is very good to excellent
[17] Based on the evaluation results of the three previous Calls for Proposals.
[18] On finished projects. (not all projects will be finished by 2013)
[19] Based on the projects funded under the 2008 Call for Proposals.
[20] Based on budget allocated to SMEs in projects
[21] Based on the projects funded under the 2008 Call for Proposals.

3.5 Call for Proposals 2011: Specific Procedures

3.5.1 Call fiche

Call title: FCH JU Call for Proposals 2011 Part 1

Call identifier: FCH-JU-2011-1

Publication date: 03 May 2011

Indicative deadline: 18 August 2011 at 17.00 (Brussels local time)

Indicative budget[22]: EUR 109 million from the FCH JU 2011 budget[23].

The final budget awarded to this call, following the evaluation of projects, may vary by up to 10% of the total value of the call.

All budgetary figures given in this call are indicative. The repartition of the sub-budgets awarded within this call, following the evaluation of proposals, may vary by up to 10% of the total value of the call. The attention of the applicants is called on the fact that the awarding of grants is subject to the approval by the European Commission of a financing decision allowing the transfer of the related funds to the FCH Joint Undertaking.

Topics called:

Area/ Topics called	**Funding Schemes**	**Indicative FCH JU Funding** **Million €**
Area SP1-JTI-FCH.1: Transportation & Refuelling Infrastructure		**36.0**
SP1-JTI-FCH.2011.1.1 Large-scale demonstration of road vehicles and refuelling infrastructure IV	Collaborative Project	
SP1-JTI-FCH.2011.1.2 In-situ characterization and diagnostic techniques for optimisation of water management and state of health determination of PEMFC	Collaborative Project	
SP1-JTI-FCH.2011.1.3 Improvement of PEMFC performance and durability through multi-scale modelling and numerical simulation	Collaborative Project	
SP1-JTI-FCH.2011.1.4 Periphery – FC-System Components	Collaborative Project	

[22] A reserve list will be constituted if there are a sufficient number of good quality proposals.
[23] The funding includes the FCH JU's own budget only. The final total funding for projects is expected to be increased by EFTA contributions (up to 2.3 M€).

Area/ Topics called	Funding Schemes	Indicative FCH JU Funding Million €
SP1-JTI-FCH.2011.1.5 Next generation European MEAs for transportation applications	Collaborative Project	
SP1-JTI-FCH.2011.1.6 Investigation of degradation phenomena	Collaborative Project	
SP1-JTI-FCH.2011.1.7 Research & development on Bipolar Plates	Collaborative Project	
SP1-JTI-FCH.2011.1.8 Research & Development of 700 bar refuelling concepts & technologies	Collaborative Project	
SP1-JTI-FCH.2011.1.9 Fuel cell systems for airborne application	Collaborative Project	
SP1-JTI-FCH.2011.1.10 Pre-normative research on fast refuelling	Collaborative Project	
Area SP1-JTI-FCH.2: Hydrogen Production & Distribution		**16.0**
SP1-JTI-FCH.2011.2.1 Demonstration of MW capacity hydrogen production and storage for balancing the grid and supply to a hydrogen refuelling station	Collaborative Project	
SP1-JTI-FCH.2011.2.2 Demonstration of hydrogen production from biogas for supply to a hydrogen refuelling station	Collaborative Project	
SP1-JTI-FCH.2011.2.3 Biomass-to-hydrogen (BTH) thermal conversion process	Collaborative Project	
SP1-JTI-FCH.2011.2.4 Novel H2 storage materials for stationary and portable applications	Collaborative Project	
SP1-JTI-FCH.2011.2.5 New generation of high temperature electrolyser	Collaborative Project	
SP1-JTI-FCH.2011.2.6 Low-temperature H2 production processes	Collaborative Project	
SP1-JTI-FCH.2011.2.7 Innovative Materials and Components for PEM electrolysers	Collaborative Project	

Area/ Topics called	Funding Schemes	Indicative FCH JU Funding Million €
SP1-JTI-FCH.2011.2.8 Pre-normative research on design and testing requirements for metallic components exposed to H2 enhanced fatigue	Collaborative Project	
SP1-JTI-FCH.2011.2.9 Measurement of the quantity of hydrogen delivered to a vehicle	Collaborative Project	
Area SP1-JTI-FCH.3: Stationary Power Generation & CHP		**38.0**
SP1-JTI-FCH.2011.3.1 Next generation stack and cell design	Collaborative Project	
SP1-JTI-FCH.2011.3.2 Advanced control for stationary power applications	Collaborative Project	
SP1-JTI-FCH.2011.3.3 Component improvement for stationary power applications	Collaborative Project	
SP1-JTI-FCH.2011.3.4 Proof-of-concept fuel cell systems	Collaborative Project	
SP1-JTI-FCH.2011.3.5 Validation of integrated fuel cell system readiness	Collaborative Project	
SP1-JTI-FCH.2011.3.6 Field demonstration of large stationary fuel cell systems for distributed generation and other relevant commercial or industrial applications	Collaborative Project	
SP1-JTI-FCH.2011.3.7 Field demonstration of small stationary fuel cell systems for residential and commercial applications	Collaborative Project	
SP1-JTI-FCH.2011.3.8 Pre-normative research on power grid integration and management of fuel cells for small residential, commercial and industrial applications	Collaborative Project	
Area SP1-JTI-FCH.4: Early Markets		**15.0**
SP1-JTI-FCH.2011.4.1 Demonstration of fuel cell-powered Material Handling vehicles including infrastructure	Collaborative Project	
SP1-JTI-FCH.2011.4.2 Demonstration of application readiness of Back-Up Power and Uninterruptible Power Systems	Collaborative Project	

Area/ Topics called	Funding Schemes	Indicative FCH JU Funding Million €
SP1-JTI-FCH.2011.4.3 Research and development of 1-10kW fuel cell systems and hydrogen supply for early market applications	Collaborative Project	
SP1-JTI-FCH.2011.4.4 Research, development and demonstration of new portable Fuel Cell systems	Collaborative Project	
SP1-JTI-FCH.2011.4.5 Research and development of Balance of Plant items for small portable and other fuel cell devices	Collaborative Project	
Area SP1-JTI-FCH.5: Cross-cutting Issues		**4.0**
SP1-JTI-FCH.2011.5.1 Assessment of benefits of H2 for energy storage and integration in energy markets	Coordination and Support Actions (Supporting Action)	
SP1-JTI-FCH.2011.5.2 Study of Financing Options to accelerate commercialisation of hydrogen and fuel cell technologies	Coordination and Support Actions (Supporting Action)	
SP1-JTI-FCH.2011.5.3 First responder educational and practical hydrogen safety training	Coordination and Support Actions (Supporting Action)	
SP1-JTI-FCH.2011.5.4 Development of EU-wide uniform performance test schemes for PEM fuel cell stacks	Collaborative Project	
Total indicative FCH JU Funding		**109.0**

Call for Proposals will be selective. There will be competition, based on quality and excellence, between proposals primarily, but nor exclusively, within activity areas, which may result in some topics not being supported in a given call.

Ranked lists of proposals will be established for each area. At the Panel stage, proposals from different topics with equal overall scores will be prioritised according to the overall FCH JU Annual Implementation Plan coverage. If they are still tied, they will be prioritised according to their scores for the S/T Quality criterion, then by their scores for the Impact criterion, and then by their scores for the Implementation criterion. If they continue to be tied, other characteristics agreed by the Panel members should be taken into account.

Proposals from the same topic with equal overall scores will be prioritised according to their scores for the S/T Quality criterion. If they are still tied, they will be prioritised according to their scores for the Impact criterion, and then by their scores for the Implementation criterion. If they continue to be tied, other characteristics agreed by the Panel member should be taken into account.

A reserve list will be constituted if there are a sufficient number of good quality proposals. It will be used if extra budget becomes available.

3.5.2 Submission and evaluation procedure

Applications to the FCH JU for financial support to the RTD activities are made following competitive calls for proposals. Further guidelines on how to submit a proposal and related templates can be found in the Guide for Applicants, available in CORDIS and the FCH JU website[24]. An additional Excel file has been prepared to help applicants drafting their budget in a proposal (available at: http://www.fch-ju.eu/content/how-participate-fch-ju-projects). While applicants are not required to provide their budget information in the proposal using this tool, applicants should be aware that they will be requested to fill it out if they pass the evaluation thresholds. The evaluation, selection and award procedures of the FCH JU are described in the document "FCH JU - Rules for submission of proposals, and the related evaluation, selection and award procedures".

The evaluation shall follow a single stage procedure.

The evaluation criteria (including weights and thresholds) and sub-criteria, together with the eligibility, selection and award criteria, for the different funding schemes are set out in "Evaluation criteria and procedures" (4.2.1 below).

Proposals will not be evaluated anonymously.

3.5.2.1 Evaluation criteria and procedures

1. General

The evaluation of proposals is carried out by the FCH JU with the assistance of independent experts.

FCH JU staff ensures that the process is fair, and in line with the principles contained in the FCH JU rules[25].

Experts perform evaluations on a personal basis, not as representatives of their employer, their country or any other entity. They are expected to be independent, impartial and objective, and to behave throughout in a professional manner. They sign an appointment letter, including a declaration of confidentiality and absence of conflict of interest before beginning their work. Confidentiality rules must be adhered to at all times, before, during and after the evaluation.

In addition, independent experts might be appointed by the FCH JU to observe the evaluation process from the point of view of its working and execution. The role of the observer is to give independent advice to the FCH JU on the conduct and fairness of the evaluation sessions, on the way in which the experts apply the evaluation criteria, and on ways in which the procedures could be improved. The observer will not express views on the proposals under examination or the experts' opinions on the proposals.

2. Before the evaluation

On receipt by the FCH JU, proposals are registered and acknowledged and their contents entered into a database to support the evaluation process. **Eligibility criteria** for each

[24] FCH JU Rules for submission of proposals, and the related evaluation, selection and award procedures (http://www.fch-ju.eu/content/how-participate-fch-ju-projects)

[25] FCH JU Rules for submission of proposals, and the related evaluation, selection and award procedures (http://www.fch-ju.eu/content/how-participate-fch-ju-projects)

proposal are also checked by FCH JU staff before the evaluation begins. Proposals which do not fulfil these criteria will not be included in the evaluation.

A proposal will only be considered eligible if it meets all of the following conditions:

- It is received by the FCH JU **before the deadline**
- It fulfils the **minimum conditions of participation** defined in chapter 4.5.
- It is **complete** (i.e. both the requested administrative forms and the proposal description are present)
- The **content of the proposal relates to the topic(s) and funding scheme(s)**, including any special conditions set out in the relevant parts of the Annual Implementation Plan

The FCH JU establishes a **list of experts capable of evaluating the proposals** that have been received. The list is drawn up to ensure:

- A high level of expertise
- An appropriate range of competencies

Provided that the above conditions can be satisfied, other factors are also taken into consideration:

- An appropriate balance between academic and industrial expertise and users
- A reasonable gender balance
- A reasonable distribution of geographical origins
- Regular rotation of experts

In constituting the lists of experts, the FCH JU also takes account of their abilities to appreciate the industrial and/or societal dimension of the proposed work. Experts must also have the appropriate language skills required for the proposals to be evaluated.

FCH JU staff allocates proposals to individual experts, taking account of the fields of expertise of the experts, and avoiding conflicts of interest.

3. Evaluation of proposals

At the beginning of the evaluation, experts will be briefed by FCH JU staff, covering the evaluation procedure, the experts' responsibilities, the issues involved in the particular area/objective, and other relevant material (including the integration of the international cooperation dimension).

Each proposal will first be assessed independently by at least 3 experts.

The proposal will be evaluated against the pre-determined evaluation criteria and sub criteria outlined in the tables below.

Evaluation criteria applicable to **Collaborative project proposals - CP**		
S/T QUALITY **“Scientific and/or technological excellence (relevant to the topics addressed by the call)”**	**IMPLEMENTATION** **“Quality and efficiency of the implementation and the management”**	**IMPACT** **“Potential impact through the development, dissemination and use of project results”**
• Soundness of concept, and quality of objectives • Progress beyond the state-of-the-art • Quality and effectiveness of the S/T methodology and associated work plan	• Appropriateness of the management structure and procedures • Quality and relevant experience of the individual participants • Quality of the consortium as a whole (including complementarity, balance) • Appropriateness of the allocation and justification of the resources to be committed (budget, staff, equipment)	• Contribution, at the European [and/or international] level, to the expected impacts listed in the work programme under the relevant topic/activity • Appropriateness of measures for the dissemination and/or exploitation of project results, and management of intellectual property.

Evaluation criteria applicable to **Coordination and support actions (Supporting Actions type) – CSA-SA**		
S/T QUALITY **“Scientific and/or technological excellence (relevant to the topics addressed by the call)”**	**IMPLEMENTATION** **“Quality and efficiency of the implementation and the management”**	**IMPACT** **“Potential impact through the development, dissemination and use of project results”**
• Soundness of concept, and quality of objectives • Quality and effectiveness of the support action mechanisms, and associated work plan	• Appropriateness of the management structure and procedures • Quality and relevant experience of the individual participants • Quality of the consortium as a whole (including complementarity, balance) [only if relevant] • Appropriateness of the allocation and justification of the resources to be committed (budget, staff, equipment)	• Contribution, at the European [and/or international] level, to the expected impacts listed in the work programme under the relevant topic/activity • Appropriateness of measures for spreading excellence, exploiting results, and disseminating knowledge, through engagement with stakeholders, and the public at large.

Evaluation scores will be awarded for each of the three criteria, and not for the sub-criteria. The sub-criteria are issues which the experts should consider in the assessment of the respective criterion. They also act as reminders of issues to rise later during the discussions of the proposal.

The relevance of a proposal will be considered in relation to the topic(s) of the *Annual Implementation Plan* covering the call, and to the objectives of the call. These aspects will be integrated in the application of the criterion "S/T Quality", and the first sub-criterion under "Impact" respectively. When a proposal is partially relevant because it only marginally addresses the topic(s) of the call, or if only part of the proposal addresses the topic(s), this condition will be reflected in the scoring of the first criterion. Proposals that are clearly not relevant to a call ("out of scope") will be rejected on eligibility grounds.

Each criterion will be scored out of 5. Half marks can be given.

The **scores** indicate the following with respect to the criterion under examination:

0 -	*The proposal fails to address the criterion under examination or cannot be judged due to missing or incomplete information*
1 -	***Poor.*** *The criterion is addressed in an inadequate manner, or there are serious inherent weaknesses.*
2 -	***Fair.*** *While the proposal broadly addresses the criterion, there are significant weaknesses*
3 -	***Good.*** *The proposal addresses the criterion well, although improvements would be necessary*
4 -	***Very Good.*** *The proposal addresses the criterion very well, although certain improvements are still possible*
5 -	***Excellent.*** *The proposal successfully addresses all relevant aspects of the criterion in question. Any shortcomings are minor*

No weightings will be applied to the scores for the different criteria.

Thresholds will be applied to the scores. The threshold for individual criteria will be 3. The overall threshold, applying to the sum of the three individual scores, will be 10.

Conflicts of interest: Under the terms of the appointment letter, experts must declare beforehand any known conflicts of interest, and must immediately inform a staff member from the FCH JU if one becomes apparent during the course of the evaluation. The FCH JU will take whatever action is necessary to remove any conflict.

Confidentiality: The appointment letter also requires experts to maintain strict confidentiality with respect to the whole evaluation process. They must follow any instruction given by the FCH JU to ensure this. Under no circumstance may an expert attempt to contact an applicant on his own account, either during the evaluation or afterwards.

4. Individual evaluation

This part of the evaluation will be carried out on the premises of the experts concerned ("remotely").

At this first step the experts are acting individually; they do not discuss the proposal with each other, nor with any third party. The experts record their individual opinions in an Individual Evaluation Report (IER), giving scores and also comments against the evaluation criteria.

When scoring proposals, experts must *only* apply the above evaluation criteria.

Experts will assess and mark the proposal exactly as it is described and presented. They do not make any assumptions or interpretations about the project in addition to what is in the proposal.

Concise but explicit justifications will be given for each score. Recommendations for improvements to be discussed as part of a possible negotiation phase will be given, if needed.

The experts will also indicate whether, in their view, the proposal deals with sensitive ethical issues, or if it requires further scrutiny with regard to security considerations.

Scope of the call: It is possible that a proposal is found to be completely out of scope of the call during the course of the individual evaluation, and therefore not relevant. If an expert suspects that this may be the case, a staff member from the FCH JU will be informed immediately, and the views of the other experts will be sought.

If the consensus view is that the main part of the proposal is not relevant to the topics of the call, the proposal will be withdrawn from the evaluation, and the proposal will be deemed ineligible.

5. Consensus meeting

Once all the experts to whom a proposal has been assigned have completed their IER, the evaluation progresses to a consensus assessment, representing their common views.

This entails a consensus meeting (might be in the form of an electronic forum) to discuss the scores awarded and to prepare comments.

The consensus discussion is moderated by a representative of the FCH JU. The role of the moderator is to seek to arrive at a consensus between the individual views of experts without any prejudice for or against particular proposals or the organisations involved, and to ensure a confidential, fair and equitable evaluation of each proposal according to the required evaluation criteria.

The moderator for the group may designate an expert to be responsible for drafting the consensus report ("rapporteur"). The experts attempt to agree on a consensus score for each of the criteria that have been evaluated and suitable comments to justify the scores. Comments should be suitable for feedback to the proposal coordinator. Scores and comments are set out in a consensus report. They also come to a common view on the questions of scope, ethics and/or security, if applicable.

If during the consensus discussion it is found to be impossible to bring all the experts to a common point of view on any particular aspect of the proposal, the FCH JU may ask up to three additional experts to examine the proposal.

Ethical issues: If one or more experts have noted that there are ethical issues touched on by the proposal, the relevant box on the consensus report (CR) will be ticked and an Ethical

Issues Report (EIR) completed, stating the nature of the ethical issues. Exceptionally for this issue, no consensus is required.

Outcome of consensus

The outcome of the consensus step is the consensus report. This will be signed/approved (either on paper, or electronically) by all experts, or as a minimum, by the "*rapporteur*" and the moderator. The moderator is responsible for ensuring that the consensus report reflects the consensus reached, expressed in scores and comments. In the case that it is impossible to reach a consensus, the report sets out the majority view of the experts but also records any dissenting views.

The FCH JU will take the necessary steps to assure the quality of the consensus reports, with particular attention given to clarity, consistency, and appropriate level of detail. If important changes are necessary, the reports will be referred back to the experts concerned.

The signing of the consensus report completes the consensus step.

Evaluation of a resubmitted proposal

In the case of proposals that have been submitted previously to the Commission or the FCH JU, the moderator will inform the experts and, if possible, give them the previous evaluation summary report (see below) at the consensus stage, if the previous evaluation took place under comparable conditions (e.g. broadly similar work programme topics and criteria). If necessary, the experts will be required to provide a clear justification for their scores and comments should these differ markedly from those awarded to the earlier proposal.

6. Panel review

This is the final step involving the independent experts. It allows them to formulate their recommendations to the FCH JU having had an overview of the results of the consensus step.

The main task of the panel is to examine and compare the consensus reports in a given area, to check on the consistency of the marks applied during the consensus discussions and, where necessary, propose a new set of scores.

The panel comprises experts involved at the consensus step. One panel will cover the whole call.

The tasks of the panel will also include:

- hearings with the applicants of those proposals that have passed thresholds (see below)
- reviewing cases where a minority view was recorded in the consensus report
- recommending a priority order for proposals with the same consensus score
- making recommendations on possible clustering or combination of proposals.

The panel is chaired by the FCH JU or by an expert appointed by the FCH JU. The FCH JU will ensure fair and equal treatment of the proposals in the panel discussions. A panel *rapporteur* will be appointed to draft the panel's advice.

The outcome of the panel meeting is a report recording, principally:

- An evaluation summary report (ESR) for each proposal, including, where relevant, a report of any ethical issues raised and any security considerations
- A list of proposals passing all thresholds, along with a final score for each proposal passing the thresholds and the panel recommendations for priority order
- A list of evaluated proposals having failed one or more thresholds
- A list of any proposals having been found ineligible during the evaluation by experts
- A summary of any deliberations of the panel

Since the same panel has considered proposals submitted to various parts of a call (for example different funding schemes, or different application areas that have been allocated distinct indicative budgets in the Annual Implementation Plan), the report may contain multiple lists accordingly.

The panel report is signed by at least three panel experts, including the panel *rapporteur* and the chairperson. If necessary, a further special ethical review of above-threshold proposals might be organised by the FCH JU.

3.5.3 Indicative evaluation and contractual timetable

Evaluation of proposals is expected to be carried out in September 2011.

Evaluation results are estimated to be available within 2 months after the closure date.

This Annual Implementation Plan provides the essential information for submitting a proposal to this call. It describes the content of the topics to be addressed, and details on how it will be implemented. The part giving the basic data on implementation (deadline, budget, additional conditions etc) is presented in the Call fiche.

- **<u>Indicative</u> timetable for this call**

Publication of call	*03 May 2011*
Deadline for submission of proposals	*18 August 2011 at 17.00 (Brussels local time)*
Evaluation of proposals	*September 2011*
Evaluation Summary Reports sent to proposal coordinators ("initial information letter")	*October 2011*
Invitation letter to successful coordinators to launch grant agreement negotiations with the FCH JU	*January 2012*
Signature of first FCH JU grant agreements	*From May 2012*
Letter to unsuccessful applicants	*From May 2012*

- **Further information and help**

The FCH JU website (call 2011 page) and CORDIS call page contain links to other sources that you may find useful in preparing and submitting your proposal. Direct links are also given where applicable.

- **Call information**

CORDIS call page and FCH JU calls web-page:

http://cordis.europa.eu/fp7/dc/index.cfm

http://www.fch-ju.eu/content/call-2011

- **Specialised and technical assistance:**

CORDIS help desk http://cordis.europa.eu/guidance/helpdesk/home_en.html

EPSS Help desk support@epss-fp7.org

IPR help desk http://www.ipr-helpdesk.org

FCH JU reference documents are available at the website:

http://www.fch-ju.eu/content/how-participate-fch-ju-projects

3.5.4 Consortium

The legal entities wishing to participate in a project shall form a consortium and appoint one of its members to act as its coordinator. In general, the coordinator should come from the IG or from the RG.

3.5.5 Particular requirements for participation, evaluation and implementation

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

The minimum conditions to be fulfilled for Collaborative Projects and Coordinating Actions funded by the FCH JU shall be the following:

(a) At least 3 legal entities must participate, each of which must be established in a Member State or an Associated Country, and no two of which are established in the same Member State or Associated Country

(b) All 3 legal entities must be independent of each other as defined in Article 6 of the Rules for Participation of the Seventh Framework Programme[26]

[26] 1. Two legal entities shall be regarded as independent of each other where neither is under the direct or indirect control of the other or under the same direct or indirect control as the other.

2. For the purposes of paragraph 1, control may, in particular, take either of the following forms:

(a) the direct or indirect holding of more than 50 % of the nominal value of the issued share capital in the legal entity concerned, or of a majority of the voting rights of the shareholders or associates of that entity;

(b) the direct or indirect holding, in fact or in law, of decision making powers in the legal entity concerned.

(c) At least 1 legal entity must be a member of the IG or the RG

The minimum condition for service and supply contracts, Support Actions, studies and training activities funded by the FCH JU shall be the participation of one legal entity.

Forms of grants and maximum reimbursement rates for projects funded through the FCH JU will be specified in the FCH JU Grant Agreement.

3.5.6 Forms of grants

A grant will be awarded by means of a Grant Agreement between the FCH JU and the project participants.

The Grant Agreement will:

- provide appropriate provisions for the implementation of the RTD activities,
- ensure that appropriate financial arrangements and rules are in place relating to the intellectual property rights policy and,
- govern the relationship between the consortium and the FCH JU.

The project activities shall be financed through a financial contribution from the FCH JU and through in-kind contributions from the legal entities participating in the activities. The in-kind contribution of industry participants shall at least match the EU contribution, i.e. the financial (cash) contribution coming from the FCH JU.[27]

Reimbursement of direct costs

To ensure that industry in-kind contribution matches the FCH JU contribution, the FCH JU proceeds in two stages for the reimbursement of direct costs:

1. The FCH JU starts with maximum reimbursement rates that are aligned with FP7 upper funding limits. The reimbursement of direct costs will therefore be based on a maximum percentage of actual eligible direct costs, depending on the type of participant, funding scheme and type of activity, as follows:

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3. However, the following relationships between legal entities shall not in themselves be deemed to constitute controlling relationships:

(a) the same public investment corporation, institutional investor or venture-capital company has a direct or indirect holding of more than 50 % of the nominal value of the issued share capital or a majority of voting rights of the shareholders or associates;

(b) the legal entities concerned are owned or supervised by the same public body.

[Regulation (EC) No 1906/2006 of the European Parliament and of the Council of 18 December 2006 laying down the rules for the participation of undertakings, research centres and universities in actions under the Seventh Framework Programme and for the dissemination of research results (2007-2013)]

[27] Article 12(3) of the statutes of the FCH JU provides: *The operational costs of the FCH Joint Undertaking shall be covered through the financial contribution of the Community, and through in-kind contributions from the legal entities participating in the activities. The industry contribution shall at least match the Community's contribution. Other contributions to co-funding of activities will be considered as receipts in accordance with the Rules of Participation of the Seventh Framework Programme.*

Type of organisation	**Type of Activity**		
	RTD	Demonstration	Other (including management)[28]
Industry (other than SME)	CP: max. 50%	CP: max. 50%	CP: max. 100% CSA: max. 100%
SME	CP: max. 75%	CP: max. 50%	CP: max. 100% CSA: max. 100%
Non-profit public-bodies, universities & higher education establishments, non-profit Research organisations	CP: max. 75%	CP: max. 50%	CP: max. 100% CSA: max. 100%

Funding schemes: CP: Collaborative project

CSA: Coordination and Support Action

2. The FCH JU will apply a correction factor (reduction) to ensure the matching obligation[29]. Experience from the previous FCH JU Calls for proposals showed that these decreases might be substantial, depending on the type of activity (Research, Demonstration, Other) and type of participants (SME, university, etc) in the proposals retained for negotiation, as well as on the related matching funds provided by industrial participants in these proposals.

   The decreases will be estimated per call for proposals, after evaluation and before signing the Grant Agreement.

These provisions are further developed in the FCH JU Grant Agreement.

Identification and Reimbursement of indirect costs

Indirect costs shall represent a fair apportionment of the overall overheads of the organisation. They shall be identified according to one of the following methods:

1. Participants which have an analytical accounting system enabling to identify them may declare their **actual indirect costs**. This option is mandatory for industrial legal entities, except for those whose accounting system does not allow distinguishing direct from indirect costs.

[28] "Other" activities refer to management activities, training, coordination, networking and dissemination (including publications). It also includes coordination and support activities in case of CSA. Please note that scientific coordination is not considered to be a management activity.

[29] Article 15(3) of the statutes of the FCH JU provides: *"in case lower levels of funding will be necessary to comply with the matching principles referred to in Article 12(3)* (the industry contribution shall at least match the Community's contribution), *the decreases shall be fair and balanced proportionally with the above mentioned upper funding limits of the Rules of Participation of the Seventh Framework Programme for all categories of participants in each individual project."*

a. In Collaborative Projects, their indirect costs will be reimbursed with a maximum amount equal to 20% of the direct eligible costs, excluding its direct eligible costs for subcontracting and the costs of resources made available by third parties which are not used on the premises of the beneficiaries.

b. In Cooperation and Support actions, their indirect costs will be reimbursed with a maximum amount equal to 7% of the direct eligible costs, excluding its direct eligible costs for subcontracting and the costs of resources made available by third parties which are not used on the premises of the beneficiaries

2. Alternatively, indirect cost may be identified by means of a **flat rate of 20%** of the direct eligible costs, excluding its direct eligible costs for subcontracting and the costs of resources made available by third parties which are not used on the premises of the beneficiaries.

    a. In collaborative projects, indirect costs will be reimbursed with an amount equal to the 20% flat rate.

    b. In Cooperation and Support actions, their indirect costs will be reimbursed with an amount equal to 7% of the direct eligible costs, excluding its direct eligible costs for subcontracting and the costs of resources made available by third parties which are not used on the premises of the beneficiaries.

These provisions are further developed in the FCH JU Grant Agreement.

3.6 Call for Proposals 2011: Topic Descriptions

APPLICATION AREA SP1-JTI-FCH.1: TRANSPORTATION & REFUELLING INFRASTRUCTURE

Topic SP1-JTI-FCH.2011.1.1: Large-scale demonstration of road vehicles and refuelling infrastructure IV

Rationale

In order to start the mass production of competitive hydrogen vehicles and provision of appropriate hydrogen refuelling infrastructure in the 2015 – 2020 timeframe, continuation and extension of the large-scale demonstration projects comprising vehicles and hydrogen refuelling stations is essential.

Overall project objectives/Scope of work

The objective is to continue extending and/or interlinking the earlier hydrogen demonstration sites and to continue setting up and pursuing initial steps for the demonstration of hydrogen fuelled vehicles and the related infrastructure in European regions/municipalities, increasing public awareness and attracting additional candidates for further demonstration activities. Candidate regions/municipalities should be well populated urban areas to either bridge the regions where hydrogen infrastructures already exist or create new markets close to existing ones. The purpose of the project is to add one or more new regions with the minimum of a new hydrogen station and additional vehicles, in hubs with one or more existing refuelling stations and to address the demonstration of FCEVs within intra-urban drive patterns.

The demo project shall focus on public transport buses or a number of passenger vehicles, as well as provide high visibility. The consortium needs to develop, deliver and operate vehicles and infrastructure, including their comprehensive performance monitoring, and propose recommendations for commercialisation.

The demonstration program needs to address:

- deployment of an additional number of hydrogen vehicles and infrastructure to realise the volume targets set in the multi annual implementation plan of the FCH JU (MAIP)
- measurement, evaluation and monitoring of specific vehicle and fuelling station parameters, such as delivered from the HyLights monitoring assessment framework in order to show the potential of the technology for the industries including suppliers. Specific values are to be defined by the project group at the beginning of the project
- public awareness campaign and networking with potential candidate regions/ sites in order to accelerate the commercialization steps
- documentation on approval and certification process of vehicles and infrastructure aiming at simplification and harmonisation of approval procedures Europe wide to facilitate establishing the RCS framework required to enable the large scale deployment of vehicle and fuelling infrastructure throughout Europe
- dissemination of lessons learned and best practices for next demo sites

- perform safety due diligence for all aspects of the demonstration, including documentation of accidents and incidents and monitoring of safety issues in the context of prevailing regulations on site to provide guidelines for proper handling
- results from the demonstration project to be exchanged with other projects working on fuel cell materials, components and degradation aspects to facilitate new innovations
- It is recommended that demonstration sites should preferably be located at, or close to, the network of the Trans-European Transport Network (TENT-T), as laid out in decision No 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network (page 21)[30]

Expected outcome

The project shall provide a minimum of 5 buses and/or minimum of 10 passenger cars per site and be operational for onsite demonstration no later than one year after the project start accompanied by at least one additional fully integrated filling station capable of meeting performance targets. Filling stations for passenger cars need to be accessible for private customers/users. The hydrogen station could also be part of another funding programme, be it European, National or Regional.

The consortium needs to develop, deliver and operate vehicles and infrastructure, including their comprehensive performance monitoring, and propose recommendations for commercialisation.

Both enlargement of existing sites and interlinking of new sites are considered relevant. New classes of vehicles (e.g., delivery vans) may be included in addition to passenger cars or buses.

The new refilling stations shall qualify for the following performance targets:

- Both 35 and 70 MPa (depending on whether buses or passenger vehicles are used, respectively), refuelling capacity of 50 kg at the beginning of the project, to be extended to 200 kg H2/day ensuring that 50 cars or 5 buses can be re-fuelled per day and 5 cars or 1-2 buses can be re-fuelled within one hour by 2015
- Concept for modular upgrade of the filling station for 100 vehicles/day refuelling capacity must be provided
- Availability of the station 98% (measured in usable operation time of the whole filling station)
- Alternative filling station specifications which will ensure that 50 vehicles can be re-fuelled per day and 5 vehicles can be re-fuelled within one hour will be acceptable, or another alternative several filling stations in the region with the total filling capacity equivalent to 50 vehicles refuelled per day
- Hydrogen cost (based on an operation capital expended consideration) at station <€10/kg (excluding tax) at start of project. Cost improvements due to higher hydrogen production for higher vehicle numbers is anticipated in the course of the project. Conditions under which hydrogen cost can be reduced to < 5€ /kg should be identified. (e.g. use of by-product hydrogen)

[30] See for the consolidated version at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1996D1692:20070101:EN:PDF

- Hydrogen purity and vehicle refuelling time according to SAE and ISO specifications
- Station hydrogen production efficiency target 50 – 70%, depending on the method of production (conversion efficiency of the whole production chain from primary energy to filling nozzle)

Cost targets:

- The consortium has to show the potential to reduce cost of the vehicle by 25% for the next generation.

Technical targets for the passenger cars are:

- >2,000h vehicle operation lifetime initially, min 3,000h lifetime as program target
- MTBF >1,000 km
- Availability >95% (to be measured in available operation time)
- Tank-to-wheel efficiency >40% (NEDC)
- Pressure at filling station suitable to fill vehicles up to 700 bar CGH2

Technical targets for the buses are:

- >4,000h lifetime initially, min. 6,000h lifetime as program target
- Availability >85% with maintenance as for conventional buses
- Fuel Consumption < 11 - 13 kg H_2 / 100 km depending on drive cycle
- Pressure at filling station suitable to fill vehicles up to 350 bar CGH2

Dissemination of the activities of the project to the broad public is seen as one key part of the demonstration project. It should especially be foreseen to communicate the benefits of hydrogen and fuel cells with reference to the demonstration project. Regional authorities should support the project with communication.

Other information

The project needs to be co-funded by national, regional or private sources in order to demonstrate a strong commitment towards clean propulsion and emission free public transport. The EC funds (from FCH JU) requested for individual projects for this topic should not exceed 7 Mio Euro. Up to two individual projects may be funded.

The consortium should include automotive OEMs, integrated infrastructure equipment providers, fuel suppliers, bus fleet operators, industrial players, local and regional bodies, as appropriate. The involvement of SMEs is especially encouraged. The project should make proposals how the project can be coordinated with projects funded under the call FCH JU 2008 (topic SP1-JTI-FCH.1.1 and SP1-JTI-FCH.1.2) as well as the call FCH JU 2009 topic SP1-JTI-FCH.2009.1.1 and the call FCH JU 2010 topic SP1-JTI-FCH 2010.1.1.

Expected duration: At least 3 years

Funding scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.1.2: In-situ characterization and diagnostic techniques for optimisation of water management and state of health determination of PEMFC

Rationale

In order to reduce the overall cost of polymer electrolyte systems it is necessary to extend lifetime, increase performance and to simplify system technology. The water management of PEMFC is a crucial aspect for performance, efficiency and long term stability of fuel cell stacks and is responsible for system control complexity.

The state-of-the-art of water management in automotive fuel cell applications is still based on empirical optimization and computer simulation, largely without experimental validation. The reason is the scarcity of in-situ non-destructive methods for water detection and derivation. In the last years significant progress in method development (neutron and x-ray methods, sophisticated frequency analysis, optical visualisation) enables the rational optimisation on the basis of in-situ diagnostics.

Overall project objectives / Scope of Work

The objective is to significantly reduce cost and improve durability of PEMFCs by optimising water management based on in-situ stack diagnostics for dynamic automotive application. A pre-requisite is the development of techniques for in-situ (non-destructive), ex-situ (non-intrusive) and real-time characterization of water management capabilities at stack level, including state-of-health monitoring. The focus of the topic is on the application of the methods for fuel cell development. With the application of the in-situ diagnostic methods an advanced understanding of fuel cell processes and in particularly of water management issues in the operating fuel cell stack should be achieved. This knowledge gain should be used to improve the operation of stacks, mitigate degradation and improve technology helping to achieve the automotive goals:

- < 0.2 gPt/kW with power density > 0.9 W/cm2 (stack size) at > 0.60V
- 5,500 h operation with only 50 to 75 mV voltage loss at 0.6 A/cm2
- 300,000 load cycles with humidity changes
- 30,000 start / stop cycles

The improved in-situ diagnostic tools should have the potential of development acceleration of fuel cell stacks and support robust design options and modelling work.

Expected Outcome

- In-situ diagnostic tools with spatial resolution implemented in stacks
- Improved operation of fuel cell stacks with regard to an accepted baseline operation (to be defined in the project according to automotive goals) based on reduced humidification requirements (e.g. << 100% RH of fuel and air) or improved liquid water removal under laboratory conditions
- Demonstration of lifetime of at least 2,000 h under dynamic automotive load profiles (e.g. NEDC) with reduced humidification

- Methodologies to determine state of health of stacks

Other Information

The consortium should include academia & research institutes/centres, automotive OEMs, and supply industry with innovative SMEs with expertise in specialised areas. The consortium should have recognised expertise in the application of in-situ diagnostic tools.

The consortium should consider if the harmonised testing procedures as developed under the FP6 FCTES^{QA} project (accessible at http://fctesqa.jrc.ec.europa.eu) can be used in addition to its in-house testing procedures.

Expected duration: 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.1.3: Improvement of PEMFC performance and durability through multi-scale modelling and numerical simulation

Rationale

Improvement of PEMFC membrane-electrode assemblies (MEAs), Microporous Layers (MPLs) and Gas Diffusion Layers (GDLs) is required for cost reduction and to increase performance and durability of the new generation of automotive fuel cells. Highly complex and dynamic electrochemical, thermo-mechanical and transport processes occur inside the components of a PEMFC on a wide variety of scales, from the stack via the single cell and its components down to the atomic scale, e.g. catalyst surfaces. Validated mathematical models and numerical simulations represent powerful tools for understanding and improving these processes and their interaction.

Overall project objectives / Scope of Work

The objective of the projects submitted to this call will be the development of multi-scale (from the materials properties to the cell level) modelling approaches for best understanding of different electrochemical reactions, multiphase water transport, reactants and charge transport, thermo-mechanical and aging mechanisms of the single cell components, including experimental validation. While the development of models and methodologies for individual processes can be included in the project, particular emphasis should be placed on the coupling of individual scales over the spatiotemporal hierarchies in order to allow the prediction of macroscopic PEMFC electrochemical performance and durability.

Modelling methodologies may include quantum chemistry, molecular dynamics, mean-field and stochastic techniques, microstructure-resolved approaches, and continuum/macro-homogeneous models as well as CFD models on micro- and macroscopic level. Projects should also include, but not be dominated by, experimental approaches for model validation and parameter assessment. This may include experiments with realistic cells/components or specifically-tailored model setups.

Potentials to significantly increase existing PEMFC performance and durability benchmarks shall be assessed, for example by developing or improving design, materials, operating conditions, recovery protocols, etc, with the help of numerical simulation.

Expected Outcome

The multi-scale models shall be used for computer-based improvement of PEMFC performance and durability:

- Detailed understanding of the feedback between processes on microscopic scales and macroscopic performance and durability of the PEMFC
- Prediction of improved operating conditions, recovery protocols, materials choice, and/or component design
- Validation of model code(s) on standard test cases and by means of well-defined experiments using advanced characterisation methods and/or in-situ diagnostic tools

- Based on validated models, simulations shall be used to demonstrate the feasibility of technical targets relevant to automotive application:
- Lifetime > 5,000 h at dynamic operation according to typical load profiles in the target applications
- Efficiency > 55 % (LHV=lower heating value) at cell voltages > 700 mV for power densities typical of the targeted applications
- Pt-loadings < 0.15 g/kW

Other Information

The consortium should include research institutes, universities, automotive OEMs or an associated industry panel, and supply industry (in particular catalyst manufacturers) while also giving opportunities for innovative SMEs with expertise in specialised areas.

The consortium should consider if the harmonised testing procedures as developed under the FP6 FCTES^{QA} project (accessible at http://fctesqa.jrc.ec.europa.eu) can be used in addition to its in-house testing procedures.

Expected duration: 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.1.4: Periphery – FC-System Components

Rationale

In order to enable high volume production of fuel cell systems for market entry scenarios 2015-2020, cost optimised, compact and efficient system components as the air compressor, the anode module, the air humidifier and the air processing unit are the most important ones. Technology assessments suggest that there are still considerable potentials for improvements in terms of functionality, efficiency, manufacturability and cost for automotive application. Some basic technologies are available but need to be further developed and tested in automotive fuel cell systems to prove suitability for this application and to fulfil automotive standards and requirements.

Overall project objectives/Scope of work

The objective of this action is to develop low cost system components for a fuel cell system to a certain maturity level. The scope should be the development of an air compressor with turbine as well as the development of an associated high speed electric motor and inverter, an anode module with recirculation, an air humidifier and an air processing unit.

General technical targets for a fuel cell system

- High voltage 380 - 430 VDC
- Low voltage 9-16 VDC
- Lifetime 5,000 - 6,000 hrs
- Ambient temperature -40 … +50°C
- Freeze start -25°C

Technical key targets for the air compressor

- Air flow 300 kg/h
- Turbine inlet wet air (100 % rel. humidity)
- Turbine inlet temperature approx. 80°C
- Pressure ratio < 3.5
- Dynamics idle to max power < 800 ms
- Efficiency > 85 %
- Power density > 0.5 kW/kg

Technical key targets for the anode module

- Hydrogen feed flow 6.2 kg/h
- Hydrogen feed temperature -40°C to +95°C
- Pressure level hydrogen feed inlet 9 - 12 bar absolute

- Pressure level recirculation loop 1.2 – 3.5 bar absolute

Technical key targets for the air humidifier

- Mass air flow 15 - 330 kg/h
- Temperature 64 - 120°C
- Pressure 1.0 - 3.0 bar absolute

Technical key target for an air processing unit

- Air flows 15 - 330 kg/h

As an initial assessment a comparison of the relative merits of different technologies shall be performed, as e.g. cold turbine compared with a hot turbine and with other available air compressor technologies. The anode module offers the options to be operated either with a passive or an active recirculation device while a humidifier can be designed with plates and frames or as a tube or as an active component. An air processing unit may contain but may not be limited to an integrated humidifier bypass, a throttle valve and a charge-air intercooler at different integration levels of a fuel cell system.

Selected component configurations shall demonstrate the principle benefits in typical automotive environments with wide load range, high dynamics, shock and vibrations, subzero and hot environment, frequent start / stop cycles to achieve high reliability and long life as well as addressing energy density and efficiency criteria.

The component development activities shall reflect the standard automotive development processes as well as design to cost, reliability and robustness methods leading to a possible continuation of the project to higher volume. Test and comparison have to refer to a mid class European car under typical certification and OEM test development cycles.

Expected outcome

Components developed shall be tested and evaluated by dedicated component and system testing for automotive usage. After key component and system testing of some first samples the component shall be further developed towards the target for the automotive fuel cell system application. Further samples need to be built and tested on component and system level. Design to cost methodologies shall be applied to analyse cost and to identify cost reduction opportunities for further improvements of the respective components.

The project shall also provide advanced analysis and concepts for further system simplifications, ease of manufacturing and cost reduction reflecting typical automotive volumes.

Deliverables include furthermore milestone reports and test results.

Other information

The consortium should include automotive OEMs or subsidiaries of automotive OEMs, relevant suppliers and system integrators.

Applicants may aim for several components or just an individual component. For the development of the anode module and the air processing unit a joint collaboration with a fuel cell system developer is indispensible.

Expected duration: approx. 3 years

Funding scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.1.5: Next generation European MEAs for transportation applications

Rationale

The Membrane and Electrode Assembly (MEA) constitutes the core energy converting part of the PEMFC. Improvement of PEMFC – membranes, electrodes, and gas diffusion layers (GDLs) as well as MEA processing - is required for further cost reduction and to increase durability of next generation PEMFC stacks. Maximum fuel cell performance of state of the art membrane materials is observed at 80-90 °C. This falls significantly short of the automotive industry targets, which is for a cell temperature from sub-zero (- 25 °C) up to 130 °C, with no or little humidification of reactant hydrogen and air, since humidification increases systems complexity and costs. Higher temperature of operation is required to enable the heat generated by the fuel cell stack to be exchanged efficiently and to simplify the system management and reduce its cost. The reduction of precious metal catalyst loading of the electrodes is a key for cost abatement of stacks to competitive levels. Optimised composition and morphology of the catalyst layers as well as of the gas diffusion layers (GDLs), in combination with high quality manufacturing methods of complete MEAs, are required to maintain high power density and efficiency. Materials compatibility and chemical stability under automotive fuel cell environment and conditions are pre-requisites for reaching the targeted lifetime of 5,000 h.

Overall topic objectives / Scope of Work

The objective of this topic is to significantly reduce the cost and improve durability of PEMFCs, increase the ability to operate above 100 °C and low relative humidity (RH), while maintaining high power density. Approaches can be based on improvement of existing materials, and/or by development of innovative concepts for which the proof of principle has been given already. Development should be aimed at the particular and demanding set of properties required for transportation fuel cell application. New and alternative concepts for membranes, electrode structures and catalyst supports providing increased Pt activity and utilisation may be included. Proposals may also include the development of novel catalyst structures, platinum thrifting approaches or non-precious metal catalysts. MEA integration should be considered, and new GDL materials development may be included. Studies on structural mechanics and on electrical conductivity of the GDL and on proton conduction in the active layer are considered relevant, as well as supporting modelling efforts. The compatibility of materials and their durability, especially for high temperature operation (130 °C) consistent with very low temperature (-25°C), shall be verified by assembling high performance MEAs for benchmarking purposes. MEAs shall be tested in automotive test cycles to prove their potential to significantly increase existing automotive performance and durability benchmarks at stack level with reduced cost.

The project activities should include one or more of the following:

- Development of membrane materials and ionomer solution/dispersion having properties appropriate for transportation fuel cell application including hybrid and/or textured membranes
- Validation of the membranes and ionomers based on existing electrode concepts suited for operation temperatures above 100°C, up to 130 °C where adequate

- Development of catalysts and electrode layers allowing for significant reduction in precious metal catalyst loadings
- Optimization of GDLs and Micro Porous Layers for handling low RH levels
- Demonstration of sub-zero start-up capabilities including conductivity and mechanical robustness
- Demonstration of high temperature properties under low relative humidity, including conductivity and mechanical robustness
- Demonstration of long-term stability under automotive fuel cell conditions
- Optimisation and demonstration of MEA processing at pilot scale based on these innovative membranes, electrodes and GDL concepts
- Development and improvement of multi-scale (from catalyst to MEA) and multi-phenomena (electrochemistry, fluidics, mechanics, degradation…) modelling tools for increased understanding of performance and degradation phenomena

Expected outcome

MEAs appropriate for high temperature and low RH operation, with a significant reduction in cost and durability of at least 5,000 h under automotive conditions as well as considerations regarding pilot scale processability of MEAs and components are expected.

Technical targets are:

- Specific targets for membranes:
    - proton conductivity ≥100 mS/cm at ≤25% RH, 120 °C
    - proton conductivity >10 mS/cm at -20 °C
    - thermal stability up to 160 °C
    - area dimensional change in wet/dry (≤ 25%RH / ≥ 99%RH) conditions < 10 % after 10,000 humidity cycles
- Specific targets for GDL material:
    - Area conductivity (through plane) >2 S/cm at operating conditions
    - Conductivity (in plane) >100 S/cm at operating conditions
    - Intrinsic permeability > 10^{-12} m^2 without drastic changes during operating conditions at RH < 50%
- Specific targets for MEA:
    - Pt loadings < 0.15 g/kW
    - BoL (beginning of life) > 55% efficiency (LHV=lower heating value) at rated power density when operated on H2 (99.995% purity, min. 1.5 stoichiometry) and air (max. 5 stoichiometry)
    - BoL Power density at nominal power : > 1 W/cm^2 at 1.5 A/cm^2
    - Lifetime (EoL) > 5,000h at dynamic operation (car)* applying typical load profiles (accelerated life tests)

- Maximum EoL degradation < 10% in rated power density
- Power density > 0.9 W/cm^2 at 1.4 A/cm^2 at EoL
- Operation temperature: - 25 °C up to 130 °C
- Active surface area > 300 cm^2 with an aspect ratio of 1:3 (guidance)

** demonstrated for complete MEAs/single cells or small stacks, following commonly agreed accelerated test protocols at automotive conditions (including start-stop and freeze-thaw cycles) operating at temperatures up to 120°C. Lifetime is defined as the time until a maximum of 10% reduction in power output at peak power is reached.*

Other Information

The consortium should include academia/research institutes, materials developers, SMEs, OEMs and application related end-users. The project should be consistent with results and recommendations from recent EC funded FP6 and FP7 projects (e.g. AUTOBRANE, IPHE-GENIE, NEXTGENCELL, APOLLON-B, FCANODE and SMALLinOne). The action will have to take into account the recommendations end requirements from the AUTOSTACK project from topic SP1-JTI-FCH.1.3 – “European Stack Cluster” of the FCH JU 2008 call, to ensure synergies to European stack integration activities, as well as the topic 1.6: “Investigation of degradation phenomena of the current call. Interfacing and information sharing with current FCH JU funded projects are recommended.

The consortium should consider if the harmonised testing procedures as developed under the FP6 $FCTES^{QA}$ project (accessible at http://fctesqa.jrc.ec.europa.eu) can be used in addition to its in-house testing procedures.

Cooperation with JRC-IE (http://ie.jrc.ec.europa.eu) which is active in fuel cells testing and standardisation is to be considered by the project consortium.

Expected duration: Up to 3 years

Funding scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.1.6: Investigation of degradation phenomena

Rationale

The lifetime of a fuel cell stack and system for transportation applications is dependent upon its design, materials selection, assembling quality and its controlled performance within dynamic operating conditions. Wide variations in performance degradation of stacks and systems currently occur between different (and similar) stack and system designs. A more comprehensive and quantitative knowledge of degradation and failure mechanisms is essential to ensure improved reliability and prolonged durability under automotive conditions. Factors influencing lifetime include electrical load variations (drive cycle), water management, thermal cycling, corrosion, start-up and shut-down procedures, contaminants from fuel, air and construction materials etc. A full range of standardised diagnostic techniques and test methods needs to be developed, as well as tools for systematic identification of irreversible and reversible degradation mechanisms together with improved control algorithms for increased life times.

Overall project objectives / Scope of Work

The project should focus on critical system operating parameters and conditions for automotive applications aiming at establishing a robust methodology and develop tools for life-time assessments, reveal degradation and failure mechanisms and facilitate improvements in materials, system architectures and vehicle operating strategies. The work should include one or more of the following aspects:

- Irreversible and reversible degradation mechanism categorization assessment: stack components, (MEAs, GDLs, BPPs, seals, etc), full stacks, system components and full systems with focus on automotive operation conditions
- Stack and system operation:
  - Identify load dynamics to which stacks are exposed in systems, taking into account the load levelling effects of system auxiliaries as well as peak power devices in the system, and the impact of such load dynamics on life-time
  - Identify irreversible and reversible degradation impacts of Noise, Vibration & Harshness, EMC, thermal cycling and air quality
  - reveal impact of water management on failure modes
- Establishment and further development of diagnostic tools and lifetime determination methods revealing key stress factors and aging modes by
  - electrochemical characterization, effluent analysis etc to reveal material changes occurring in cells and linking these to performance decrease and degradation and failure mechanisms
  - development of standardised test protocols for systematic mapping of degradation and failure mechanisms, including accelerated testing
  - Simulation/emulation of concepts and novel system architectures to minimise
    - load dynamics using peak shaving components

- negative impact of start, stop and idling situations on lifetime
    - impact of sub-zero conditions on life time
    - the effect of contaminants in fuel, air and corrosion products from construction materials
- Development of models for reliable life-time prediction

Expected Outcome

- Increased knowledge with respect to the most pronounced degradation and failure mechanisms for automotive applications including:
    - Catalyst support corrosion linked to shut-down and start-up or fuel starvation
    - Catalyst dissolution, migration and re-precipitation linked to voltage excursions typically experienced in case of automotive load profiles
    - Catalyst particle growth causing loss in active catalyst area at high cell potentials (low load or idling conditions)
    - MEA layer de-lamination linked to freeze-thaw cycles
    - Pin-hole formation linked to high local temperatures during full load conditions or mechanical stress on membrane related to operation with low humidity reactant gases
- Improved degradation mitigation strategies by optimal selection of materials, clever system design as well as control algorithms for stack operation
- Inventory of degradation and failure mechanisms occurring in MEA, GDL, BPP, stack and system components and mitigation methods
- Established relationship between key factors affecting lifetime and performance degradation rate of MEA, GDL, BPP, stack and system components
- Improved understanding of the effect of various approaches to counteract degradation, such as:
    - better BOP components for peak shaving
    - improved start-stop and idling protocols
    - robust protocols for freeze proof shut-down and start-up of fuel cell system
- Established (accelerated) test protocols and lifetime determination method
- Enhanced knowledge and advice of how to prolong PEM fuel cell lifetime including properties of next generation materials with improved stability

Other Information

The consortium should include academia/research institutes, stack producers and system integrators, and may optionally include fuel cell vehicle designers and operators. The proposals should build on output from FP7 DECODE. Interfacing and information sharing with ongoing R&D projects funded by the FCH JU call topics SP1-JTI-FCH.2008.3.3, SP1-JTI-FCH.2009.3.1, SP1-JTI-FCH.2010.1.3, and under Framework Programmes, on PEM fuel cell degradation in stationary and automotive applications are recommended. Benefits are foreseen from interaction with projects funded in the 2009, 2010 and 2011 FCH call topics on electrodes and GDLs (SP1-JTI-FCH.2009.1.3) and MEAs for transportation applications (SP1-JTI-FCH.2010.1.2), and mechanisms for information exchange with them should be considered in the proposal. Links to activities in the topic area outside Europe (e.g. North America, Japan, Korea) may be explored.

The consortium should consider if the harmonized testing procedures as developed under the FP6 FCTES^{QA} project (accessible at http://fctesqa.jrc.ec.europa.eu) can be used in addition to its in-house testing procedures.

Cooperation with JRC-IE (http://ie.jrc.ec.europa.eu) which is active in fuel cells testing and standardization is to be considered by the project consortium.

Expected duration: Up to 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.1.7: Research & development on Bipolar Plates

Rationale

The bipolar plate is presently by weight, volume and cost one of the most significant components of a fuel cell stack. Bipolar plates can be made from various materials with the most common being graphite, metal, carbon/carbon and carbon/polymer composites.

The metal plate has excellent electrical bulk conductivity and can be processed with inexpensive manufacturing methods, but its major drawback is the need for a corrosion resistant conductive coating. The higher strength of metallic bipolar plates allow for higher power density stacks, which is desirable especially for transportation applications. Furthermore, metallic plates have a low thermal mass and high thermal conductivity, which is particularly beneficial for efficient cooling and rapid start-up.

Overall project objectives / Scope of Work

The project activities will include either:

- Development of (i) corrosion resistant conductive coatings for low cost metals, or (ii) bi-polar plates made from alternative non-metallic materials, including verification of long-term stability under fuel cell operating conditions, especially for high temperatures (up to 130 °C) for either technological solution, and
- Identification and quantification of levels of corrosion products and rate of formation, including assessments of their potential contamination on other cell, stack and system components

Or:

- Development of cost effective bipolar plate manufacturing technologies
- Demonstration of formability of metal/coating combination in complex configuration, assuring efficient cooling and excellent stacking capabilities, and
- Cost reduction potentials of bipolar plates for different production volumes

Expected Outcome

Depending on the direction chosen above, either:

- Sufficient handling properties for stack assembly/manufacture process, including coating scratch resistance and coating/surface adhesion.
- Corrosion stability for 5,000 h (e.g., via accelerated tests) with verified figures for emissions of detrimental contaminating species (e.g., metallic ions of Fe, Cr, Al, etc.) in the MEA including GDL
- Specific targets for bipolar plates
    - contact resistance: < 25 mΩ.cm^2 at relevant clamping pressures
    - H_2 permeability < $2*10^{-6}$ cm^3/cm^2 s
    - corrosion resistance < 10 μA/cm^2; testing conditions should be specified

- flexural strength >50 MPa
- tensile strength >40 MPa
- thermal stability up to 130 °C
- thermal expansion coefficient compatible to other stack components (sealant, MEA, GDL, stack interior gas ducts, etc) in the temperature range of -25°C to 130°C
- thermal conductivity (>10 W/m K)

Or:

- Prove by representative pilot runs the
  - feasibility of bipolar plate production at automotive relevant sizes >300 cm^2 and cell pitch < 1.5 mm
  - formability into complex geometries allowing for high power densities and of adaptability to (advanced) sealing structures and/or concepts

Irrespective of the direction chosen above, the project should demonstrate

- Reaching costs (excluding taxes and levies) less than 2.5 € /kW of rated stack power at mass production volumes (500,000 pieces annually)

Other Information

The consortium should include bipolar plate suppliers, research organisations and possibly fuel cell stack developers and application related end users and SMEs in specialised areas according to need. Projects funded should explore cooperation to projects funded under the Topic SP1-JTI-FCH.2011.1.5: "Investigation of degradation phenomena" - on the potential degradation effects of contaminants from bipolar plates.

Expected duration: 3 years

Funding Scheme: Collaborative project

<u>Topic SP1-JTI-FCH.2011.1.8: Research & Development of 700 bar retail refuelling concepts & technologies</u>

Rationale

Major car manufacturers aim for potential early market deployment of fuel cell vehicles with 700 bar on-board storage in near future. Such deployment requires availability of a cost and performance effective and competitive hydrogen refuelling infrastructure enabling a self-sustained roll-out based on national/local market support mechanisms. In comparison to ongoing demonstration of hydrogen refuelling technology, efforts are needed to further reduce costs with respect to capital expenses (CAPEX) and operational expenses (OPEX) in order to enable a feasible operation. In addition refuelling is to ensure compliance with SAE J2601 and SAE J2799 to allow for fast and safe refuelling of any type of vehicle at any type of refuelling stations worldwide, as well as general standardisations of concepts and capacities to enable cost reductions. This calls for dedicated efforts on research and development of 700bar retail refuelling concepts and technologies.

Overall project objectives / Scope of Work

Project(s) should develop new concepts and technologies for 700 bar refuelling enabling self-sustained infrastructure roll-out for anticipated early vehicle deployment volumes. Emphasis should be on reduction of CAPEX costs e.g. through simplifications and standardisation of the complete retail refuelling system and OPEX costs through optimization of efficiency and component durability. The scope of potential topics to be addressed includes, (addressing of several topics within joint proposals is preferred):

- Optimization of compression & storage systems with respect to cost, efficiency and capacity. Capacity should be sufficient for and optimised with respect to anticipated early vehicle deployment volumes both in terms of daily- (average & maximum) and instant-capacities (back-to-back and hourly profile repeatability)
- Optimization of cooling & refuelling systems with respect to cost, efficiency, capacity and accuracy. Cooling & refuelling systems should ensure full compliance with SAE J2601 and SAE J2799. Issues on accuracy and compliance with relevant EU national member states legislation should be addressed with development of components/systems fulfilling these and methods to validate the compliance
- Formulation of standardised interfaces with various hydrogen supply options in particular with respect to empty/inlet pressure and unloading and connection methods and concepts. Supply options considered: trucked-in gaseous at different pressures and pipeline/onsite
- Formulation of station concepts and standardisation suitable for early vehicle deployment volumes, in order to enable both cost and footprint reductions. Efforts should build upon similar European efforts in e.g. H2Mobility but also taking into consideration possible coordination with relevant efforts in e.g. Asia and USA
- Formulation of standardised methods and test procedures for validating compliance with SAE J2601 and SAE J2799, possibly in coordination with efforts ongoing in CSA TIR 4.3

Expected outcome

Complete 700bar hydrogen refuelling retail concepts and technologies ensuring:

- CAPEX and OPEX costs enabling self-sustained roll-out of infrastructure based on relevant and realistic national/local market support mechanisms and sufficient capacities and performances for anticipated early vehicle deployment volumes. Proposal must provide rationale for relevant targets and documentation of meeting of these and enabling of a self-sustained roll-out. Also proposal must define their state-of-the-art level and the specific progress to be achieved within the project and a plan towards reaching commercial targets
- Standardised concepts for hydrogen fuelling stations and supply interfaces at a European level preferably with international coordination
- Accurate and verified refuelling in compliance with relevant EU national member states legislation
- Full and verified compliance with SAE J2601, SAE J2799 and ISO 20100 including standardized compliance verification methods

Other Information

The consortium should include participants such as infrastructure technology providers, refuelling retail operators, energy companies and car manufactures. On research, standardisation and verification testing topics relevant and experienced organizations should be included. High involvement of innovative SMEs is beneficial. Consortium as a whole should ensure sufficient connections to various European and international efforts such as the working groups of SAE J2601, SAE J2799, CSA TIR 4.3 and H2Mobility, where applicable.

Expected duration: Up to 3 years

Funding scheme: Collaborative project

Topic SP1-JTI-FCH.2011.1.9: Fuel cell systems for airborne application

Rationale

Fuel cell systems for airborne applications (such as emergency power, RAT replacement, cabin power, APU replacement) need to meet safe operational requirements in terms of efficiency, reliability, performance, mass/volume, cost and lifetime under flight conditions at altitude and under high and low ambient temperatures in the air and on the ground.

Hydrogen based fuel cell systems are expected to facilitate the early introduction of PEM fuel cell system applications in the near-term and early examples derived from automotive system designs have already been flight or ground tested. Hydrogen is expected to provide the fuelling source on the medium term and for use in first commercial aircraft applications while reformation of aviation fuel may in the longer term provide for greater aircraft autonomy (flexibility in range and duty cycle) for future aircraft applications. Nevertheless, the available fuel cell technologies need substantial improvements to meet aircraft installation and airborne applications requirements.

Overall project objectives / Scope of Work

The overall objective is to design, develop and flight test an aircraft related fuel cell system against flight / application specific requirements.

The project should also address auxiliary subsystems optimization, covering air supply, water management, thermal and power management, and use of inert air within overall system efficiency optimization and system multi-functionality requirements.

In addition, the programme should evaluate current safety, codes and standards (derived from automotive applications) and how these will need to be extended to meet regulations and standards applicable to aircraft requirements.

The proposed demonstrator should be in the power range of 30-100kW, where it is representative of and appropriate to system power output and functionality in order to provide proof of concept for the application.

Expected Outcome

The system is expected to be fuelled by hydrogen and should achieve:

- Fuel cell system efficiency (LHV) at 25% of rated power: 55%
- Durability with cycling hours: 2,500 under flight representative load profiles
- Fuel cell system lifetime 3,500 hours
- Fuel cell system power density W/L: 400 (EoL)
- Fuel cell system specific power W/kg: 650 (EoL)
- Fuel cell system operational capability at ambient temperature ranges and cycles typical for such packaged systems in aircrafts
- Fuel cell system operational capability at ranges of altitude and in-flight variations typical for such packaged systems in aircrafts

- Set of system design and operational recommendations together with future development targets including identification of areas for improvement of existent system technologies to meet aircraft installation and airborne application needs, also taking into account proposed regulations for fuel cell system on board aircrafts
- Proof of concept and validation of operational performance up to full “real life” operating conditions for key components and the entire fuel cell system, according to the maturity of the proposed technologies, in flight mode
- Proof of concept of H2 storage and supply on-board an aircraft

Other Information

The consortium is expected to include system integrators (OEMs), fuel cell technology suppliers, application related end-users and possibly regulatory officials, including opportunities for research organisations and SMEs in specialised areas design, installation, operation and test / certification roles.

Expected duration: 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.1.10: Pre-normative research on fast refuelling

Rationale

Hydrogen vehicle refuelling needs to be performed according to a pre-defined protocol to ensure that the correct quantity of hydrogen is transferred safely and in optimal conditions. Going from 35 MPa to 70 MPa has required the introduction of pre-cooling and increased the reliance on the refuelling protocol to avoid potentially hazardous temperature deviations. A joint automotive resp. energy industry document SAE Technical Information Report (TIR) J2601 providing a validated protocol for all refuelling pressures including 70 MPa with pre-cooling has recently been published and is currently applied as a worldwide standard when setting up hydrogen filling stations. There are however opportunities to optimise the formulation of requirements, as not all the tank constructions used in the different fuelling applications (including buses and forklifts) require the same level of pre-cooling, and more refined approaches could be applied, resulting in less stringent pre-cooling requirements.

Overall project objectives / Scope of Work

- Identify, define, and evaluate approaches for optimised fuelling procedures, with regards to required pre-cooling and/or allowable filling speed
- Evaluate the influence of tank construction on the maximum allowable filling speed

Expected Outcome

- Identification of opportunities for optimization
- Evaluation of potential benefits provided by these opportunities with regards to refuelling performance and constraints, as well as refuelling safety
- Proposed approach for standardisation, by means of a protocol covering requirements on both the vehicle and dispenser side
- In addition it is considered important to investigate improved approaches that would allow to carry out fuelling with less pre-cooling, for instance by taking more accurately into account the temperature of the tank materials, as well as the tank characteristics for determining maximum pressure ramp rates for a further optimization of SAE J2601. Such an approach has to be usable for both type III and type IV CGH2 systems. In any case, for passenger vehicles, the requirement of a re-filling within three minutes needs to be ensured, also the overall usable hydrogen capacity for type III and type IV vessels should not be decreased in comparison to the existing state-of-the art
- Experimental implementation and evaluation of selected approaches
- Recommendations for implementation in international standards based on the assumption of keeping a high level of compatibility to existing protocols and the filling stations based on this document

Other Information

The consortium should include dispensing technology providers, vehicle OEM's and/or vehicle fuel system developers, testing entities, and involve standardisation experts.

Interfacing and information sharing with the FCH JU funded project HyComp is recommended.

Expected duration: Up to 2 years

Funding Scheme: Collaborative Project

APPLICATION AREA SP1-JTI-FCH.2: HYDROGEN PRODUCTION & DISTRIBUTION

Topic SP1-JTI-FCH.2011.2.1: Demonstration of MW capacity hydrogen production and storage for balancing the grid and supply to a hydrogen refuelling station

Rationale

Hydrogen as an energy carrier is recognised as a possible way to: (i) increase the use of intermittent renewable energy sources, potentially limited by electrical grid balance constraints, by providing an effective means to store energy produced in excess of immediate consumption, for any later use; and (ii) decarbonise the transport sector.

Having a part of the transport sector's energy needs met with intermittent renewable energy converted to hydrogen effectively increases the share of renewable energy in both the overall and transportation energy mix. Hydrogen can either be produced onsite at the Hydrogen Refuelling Station (HRS) (which requires an increased footprint not always available and leaves open the issue of managing intermittent renewable energy), or coupled to the electricity producer (which needs logistics for hydrogen delivery but offers dispatchability to the producer). Other more convenient topologies which meet both requirements of better grid services and enhanced hydrogen logistics may be explored.

Hydrogen production by water electrolysis and storage above ground in compressed gas form for subsequent use are both known technologies that are available at enough capacity as required both for decentralised grid balancing and massive fuel supply to the transportation sector, but have not been intensively validated and demonstrated yet. There is a need to *demonstrate* system level technology readiness and generate further facts-based data for deployment studies through implementation of all the functions required to bring intermittent renewable energy to vehicles with hydrogen as the energy carrier. Hydrogen produced by these means could in the interim serve also for conversion to electricity in peak hours, when very special pricing conditions or restrictions are met, or as high-grade chemical for various uses.

Overall project objectives / Scope of Work

The objective is to demonstrate the technological readiness, performance, reliability and total cost of ownership of installations for production and short-term storage of hydrogen via electrolysis from renewable electricity sources, with subsequent supply as a high value fuel/chemical, such as a hydrogen vehicle refuelling station (retail, public transport, or fleets) or other uses as well as grid services as controllable load.

The aim is to show that providing hydrogen to transport applications from grid electricity can be an economically viable solution for reducing green house gas emissions of transport while facilitating intake by the grid of renewable energy.

Means for the production of electricity, logistics of the hydrogen produced and equipment for the use of the hydrogen are out of scope.

Optimal logistics from the production site to the point of use (by road transport or existing pipeline) as well as advantages related to the infrastructure needed (dedicated electricity distribution lines) should be considered to select proper locations for the demo site.

Expected Outcome

- Definition of a standard optimised hydrogen production and storage system as a function of grid balancing constraints, as reflected by the spot purchase price, and local hydrogen fuel needs
- Installation and continuous operation of a standalone forecourt size electrolyser (between 100 and 500 kg/day) associated with a hydrogen storage system, used as a source of supply of CO2-free or high-grade hydrogen (e.g. for the operation of a fleet of hydrogen vehicles such as buses, material handling trucks, passenger cars), and other possible applications as well
- Study of regulatory aspects associated with the implementation of this integrated energy function, such as access to spot purchase prices, renewable electricity certificates, as well as RCS related to hydrogen production and stationary storage; identification of barriers to deployment and recommendations to address them
- Evaluation of capacity utilisation, economics, efficiency, and availability based on actual operation. Targets for operation are:
    - Efficiency > 55% (WtT)
    - Cost of hydrogen delivered short term < 15 €/kg, long-term < 7 €/kg
    - Hydrogen production facility turn-key CAPEX: 3.5 M€/(t/d) (i.e. 1.7 M€/MWel)
    - Hydrogen quality ISO/DIS 14786-2 compliant
    - Availability > 95%
    - > 12,000 h operation within the project, expected durability >10 years
- Assessment of CAPEX and cost of hydrogen delivered evolving with volume (both size of installation and number of installations deployed)
- LCA/LCI analysis (ILCD compliant)

Other Information

The consortium should include an electrolyser manufacturer, as well as the required actors for system integration (including storage), operation and hydrogen fuel delivery, and RCS experts.

The vehicle fleet(s) and hydrogen refuelling stations to which the produced hydrogen will be made available shall be identified (these are not in the scope of this proposal).

Projects should be coordinated with other existing hydrogen vehicle and hydrogen refuelling station deployment projects, and evidence of cooperation has to be stated in the proposal.

Expected duration: Up to 5 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.2.2: Demonstration of hydrogen production from biogas for supply to a hydrogen refuelling station

Rationale

Conversion of biogas to hydrogen for use in fuel cell vehicles is not only a way forward towards a decarbonised transport, but also an energy efficient pathway for implementing this renewable primary energy in the transport sector.

Mature and cost effective technologies for biogas conversion to fuel cell grade hydrogen are available. There is a need to demonstrate system level technology readiness at the MW level through implementation of all the functions required to bring bio-resource energy to vehicles with hydrogen as the energy carrier.

Overall project objectives / Scope of Work

The objective is to demonstrate the technological readiness, performance, reliability and total cost of ownership of installations for production and short-term storage of hydrogen from biogas with subsequent supply as a high value fuel to e.g. a nearby vehicle fuelling stations (retail, public transport, or fleets), by road transport or pipeline.

The aim is to show that providing hydrogen to transport applications from biogas can be an economically viable solution for reducing green house gas emissions of transport.

Means for the production of biogas, logistics of the hydrogen produced and equipment for the use of the hydrogen are out of scope.

Optimal logistics from the production site to the point of use (by road transport or pipeline) should be considered to select proper locations for the demo site.

Expected Outcome

- Installation and continuous operation of a standalone forecourt size hydrogen production unit from biogas (between 100 and 500 kg/day), associated to a hydrogen storage system, with means of supply to a fuelling station.
- Study of relevant regulatory aspects associated with use of renewable certificates, access to spot purchase prices, as well as RCS relative to hydrogen production and stationary storage. Identification of barriers to deployment and recommendations to address these.
- Evaluation of costs, efficiency, and availability based on actual operation. Targets for operation are:
    - Efficiency > 80% (WtT)
    - Cost of hydrogen delivered short term < 10 €/kg, long-term < 5 €/kg
    - Hydrogen production facility turn-key CAPEX: 6 M€/(t/d)
    - Availability > 95%
    - > 25,000 h operation within the project, expected durability >10 years
    - Hydrogen quality ISO/DIS 14786-2 compliant

- Assessment of CAPEX and cost of hydrogen delivered evolving with volume (both size of installation and number of installations deployed). LCA/LCI analysis (ILCD compliant) to be conducted
- LCA/LCI analysis (ILCD compliant)

Other Information

The consortium should include a BtH conversion/gas purification equipment supplier, as well as the required actors for system integration (including storage), operation and hydrogen fuel delivery, and involve RCS experts.

The vehicle fleet and fuelling stations that will be supplied shall be identified (these are not in the scope of this proposal). Projects should be coordinated with existing hydrogen vehicle and refuelling station deployment projects, and evidence of cooperation has to be stated in the proposal.

Expected duration: Up to 5 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.2.3: Biomass-to-hydrogen (BTH) thermal conversion process

Rationale

The various thermal conversion technologies for hydrogen production from CO_2-neutral precursors need to be addressed in terms of cost, efficiency and scalability, especially for the application to decentralised production schemes. In order to achieve maturity, hydrogen production equipment based on the use of biomass has to be further developed. Under this topic development of BTH thermal H_2 production methods in order to allow hydrogen production from biomass, increase well-to-tank efficiency and contribute to a sustainable energy portfolio, is foreseen.

Overall project objectives / Scope of Work

Scope of work comprises development and scale up activities on materials and reactors design in order to obtain a continuous process for hydrogen production from biomass. The final target should be to demonstrate the technical and economical viability of the global process.

The project shall focus on:

- Conception of low cost and energy efficient systems to produce hydrogen from solid and liquid biomass. Assessment of performance in terms of efficiency
- Improvement of pre-treatment for different types of feedstock
- Design and build a reactor for the continuous production of hydrogen at a pre-commercial scale, improving with respect on the current state of the art and pilot plants
- Feasibility assessment of the process taking into account the purity of the hydrogen produced (PEMFC grade), by-products and effluents
- Economical assessment of the pre-treatment of the potential feedstock

Hydrogen production by means of different pathways is left open (catalytic thermal decomposition, steam gasification, solar-driven biomass gasification, autothermal reforming, waste steam gasification, others) as well as feedstock, including sewage sludge, municipal organic wastes and other ordinary wastes.

Expected Outcome

Reactors in the forecourt size range for a hydrogen filling station (100 to 500 kg/day) , with high integration to minimise use of external heating and increasing overall efficiency, are foreseen.

Key performance indicators:

- Heating value of the gas, including purification, related to heating value of the feedstock > 66%
- Scalability minimum to 500 kg/day
- Durability > 10 years (80,000 h) with availability > 95%. Evidence should be given in the proposal on expected lifetime of the concept and methodology to evaluate it

- Low system cost, 5 €/kg of H2, including CAPEX
- LCA/LCI analysis (ILCD compliant) to be conducted

Other Information

The consortium should include broad industry, as well as SMEs, in the field of reactor technologies, catalyst materials and design and integration systems in general, and research institutions. Activity should be coordinated with other projects in the purification field and with biofuel ETP.

Expected duration: 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.2.4: Novel H_2 storage materials for stationary and portable applications

Rationale

Several past and current European projects (STORHY, NESSHY, COSY, NANOHY, FLYHY) have shown the high potential of novel materials for energy efficient and compact hydrogen storage, and have demonstrated first prototype storage tanks. It became clear that the different material classes which have been investigated offer diverse advantages with respect to temperatures of operation, overall energy consumption, reaction kinetics, or weight and especially volume-related hydrogen storage capacities, when compared to compressed or liquid hydrogen storage. But in order to use them in real applications, often a trade off between materials properties oriented to the application has to be found.

Therefore, further fundamental and break-through multidisciplinary research on novel solid hydrogen storage materials, based on and extending the findings of these projects, is needed. The goal is to achieve and demonstrate the full potential of these materials with respect to increased energy efficiency and storage capability in selected application areas of industrial relevance and market potential and storage capability, i.e. to develop new hydrogen storage technology, suitable for stationary, portable and transport applications, with the exception of buses, trucks and passenger cars. The knowledge of thermodynamic and kinetic properties of the developed hydrogen storage materials is a fundamental aspect for real applications.

Overall project objectives / Scope of Work

Novel energy efficient, compact and cost effective hydrogen storage solutions are to be developed for prototype integration in existing applications in one or more of the following areas:

- Hydrogen storage for supply of PEM FC, HT-PEMFC or SOFC systems for stationary (e.g. net independent power supply, CHP) as well as portable and transport applications (e.g. water and air bound or space transport, but excluding road transport) with industrial relevance and market potential
- Hydrogen storage for direct supply of special industrial applications (e.g. glass industry)
- Hydrogen storage to enable continuous supply from, e.g. bio and natural gas reforming, or from intermittent sources like biological and photocatalytic processes, solar thermal processes, or electrolysis using electrical power directly from solar or wind energy

Optimised materials for hydrogen storage can be based on the following:

- Borohydrides
- Amide/Imide systems
- Nanostructured and metastable metallic hydrides
- Composites with other hydrides based on the aforementioned storage materials
- Chemical (e.g. anion and cation) modifications on the aforementioned storage materials
- Confinement of hydrogen storage materials in nanoporous scaffolds
- Porous hydrogen storage materials

Other material categories (polymers, ceramics, etc) or compounds showing hydrogen sorption in solid or in liquid state can be also considered. Suitable modelling for estimation and assessment of materials structure and properties should be included in the project.

Activities shall include break-through basic research in the material classes mentioned above, as well as development of storage systems. Study of complete applications of storage systems in the aforementioned fields as well as prototyping should be included in the work plan.

Having defined a target application, projects should investigate the improvement of storage capacity, reaction kinetics for adequate hydrogen loading and unloading properties (e.g. by suitable processing, use of additives and catalysts), reaction thermodynamics for increased energy efficiency and lowered temperatures of operation (e.g. by suitable composites, by anion or cation substitution), cycling stability, and potential of thermal integration with the application considered.

Starting with a focus on most promising material classes for the chosen target applications, a careful materials downselection process should take place early enough in the project execution to allow for a concentration of the resources available on the development of the most promising candidates to reach the project targets. A description of the materials selection strategy should be included in the work plan.

Projects should also investigate how far a cost reduction by use of less pure raw materials and improved cost efficient methods of synthesis can be achieved. Furthermore, the effects of low quality hydrogen on stability of the storage properties should be considered.

Expected Outcome

Outcome of the projects should be one or more of the following:

- Storage materials with capacities ≥ 6 wt.%, ≥ 60 kg H2/m3 reversibly releasing hydrogen at operating temperatures compatible e.g. with PEM FC, HT PEM FC or SOFC / MCFC or other applications and appropriate hydrogen loading and unloading kinetics for the envisaged application
- Small scale prototype storage systems with significantly improved storage capacity compared to compressed gas storage (≥ 4 wt.%, ≥ 40 kg H2/m3), taking into account the reversible charge/discharge cyclability
- Indicator of allowable hydrogen purity for stable storage properties

- Cost effective production routes of the materials, giving opportunities to SMEs in the field of materials production
- Demonstrate the potential up-scaling for reaching in the long run a target cost of 500 €/kg of stored H2 at the system level with a significant decrease of overall lifetime cost compared to the state-of-the-art in the special application. Possible integration of thermal energy to the storage system has to be taken into account in the economic assessment

Other Information

Projects shall not duplicate outcomes achieved already in past and current European and JU projects on materials research for solid state hydrogen storage, but extend these results. The consortium should include broad Industry & Research participation. Projects should open new market chances for SMEs in the fields of production of hydrogen storage materials. Potential for cooperation with JRC-IE (http://ie.jrc.ec.europa.eu) is to be explored by the consortium.

Expected duration: Up to 4 years

Funding Scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.2.5: New generation of high temperature electrolyser

Rationale

High temperature electrolysis (HTE) has excellent perspectives for an efficient use of renewable solar, wind or geothermal as well as nuclear energy, especially for large-scale centralised hydrogen production, and with substantial improvement of energy-efficiency. Overcapacities from renewable energy resources, as well as dedicated renewable energy production, can be transformed into fuels for the transport sector. HTE has the advantages of high conversion efficiency (expected to become above 90%), and that external heat sources, such as waste heat from industrial production or from natural, underground sources, can increase even further the efficiency. HTE can electrolyse also CO_2 into CO. By a syngas (CO + H_2) production, synthetic fuels such as methanol, methane, and DME can be produced, which are used easily in the existing infrastructure.

More efficient HTE systems will require high temperatures, pressurised systems and next generation of cells and stacks, which have to be further developed and up-scaled. Progress has already been obtained for HTE (e.g. in the RelHy project), in part because it is building on the SOFC development. However, there are still gaps to cover pressurised systems, stack development and system development, which is needed to bring the technology closer to the demonstration phase. Alongside with needed up-scaling, long-term research is required to help overcome technical constraints and allow proof of concept technology demonstration.

Overall project objectives / Scope of Work

- Develop cells and up-scaling the production of such cells that can sustain the conditions needed, high current loads (> 1 Acm-2), high durability and reliability, high temperature (700-1000º C), and show the potential for efficient, reliable, environmentally friendly and economically feasible production of hydrogen. Optional syngas production from CO2 and steam is also valuable
- Demonstrate low degradation rate (< 0.5% per 1,000 h) under the electrolysis conditions (high humidity, high current density, high temperature), and sufficient mechanical strength for large area cells
- Develop concepts of HTE for use in connection with renewable energy production (wind, solar) and nuclear power
- Develop concepts for pressurised electrolysis for more economical systems (production of hydrogen, but also methane, methanol or DME are valuable)
- Test and evaluation of cells, stacks and systems under realistic conditions

Expected Outcome

- Development of cells and stacks designed for high-temperature (800-1000 ºC), high current density (>1 Acm-2), pressurised conditions
- Manufacture of dedicated HTE cells and stacks for use in large systems for the conversion of electricity from renewable sources and from nuclear power, i.e. large-area cells, high durability under realistic conditions

- Demonstration of a HTE system of kW size under realistic conditions (high humidity, high temperature, pressurised, fluctuating production), showing degradation around 1% per 1,000 h of operation, and durability that can be extrapolated to minimum 5 years of continuous operation
- Proof-of-concept for co-electrolysis, syngas production and final chemical product, and validation of efficiency figures. Total efficiencies are expected in the 85-95% range

Other Information

Projects shall not duplicate outcomes achieved already in past and current European and JU projects on HTE, but extend these results. The consortium should include broad Industry & Research participation.

Expected duration: 4 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.2.6: Low-temperature H_2 production processes

Rationale

Low temperature hydrogen production technologies are very promising for decentralised applications: water splitting using solar energy, photocatalytic and photoelectrochemical reforming of low or negative cost organic compounds (e.g., wastewaters, surplus or waste materials from biomass processing industries, etc.) at ambient conditions or fermentation technologies is likely to play an important role in hydrogen production from renewable resources. To achieve this, basic research is necessary to develop efficient chemical or biological systems converting solar energy into chemical energy for water splitting, photo(electro)reforming of organics and biomass components and derivatives or to directly convert biomass into hydrogen by fermentation processes. In addition, applied research and development is necessary to design and construct devices that efficiently produce and collect the hydrogen.

Overall project objectives / Scope of Work

The objectives of the project should be to develop novel materials, systems and concepts in the following fields:

- Improved materials and chemical/biological systems for low temperature water splitting using solar radiation
- Improved and novel nanostructured materials for photo-processes comprising photo-catalysts, photo anodes interfaced with liquid or new polymer electrolytes
- Direct photocatalytic splitting of water at ambient conditions using solar radiation
- Photobiological production of hydrogen from water (biophotolysis) via to develop new efficient biological converters, microalgae cultures, and low cost photobioreactors
- Photocatalytic and photoelectrochemical reforming of low cost organic compounds (e.g., wastewaters, surplus or waste materials from biomass processing industries, etc.) at ambient conditions using solar radiation
- Dark fermentation of different typology of waste or second generation biomass for the production of bio-hydrogen (with possible biogas co-production), including fractionation of lignocellulosic feedstock with high potential of mobilization of fermentable sugars

Efficient, easy to handle systems shall be developed and the low temperature hydrogen production process shall be demonstrated in small scale reactors. The reactors should be compact and allow an easy integration in small to medium scale applications ranging from 100 W for domestic use (ca. 3 g/h H_2 equivalent) up to 100 kW (ca. 3 kg/h H_2 equivalent) for commercial use. Different types of reactors might be optimal for the different application scales, and the efficiency should be evaluated for the anticipated application.

Expected Outcome

Chemical/biological system technologies:

- Novel photo catalytic and photo electrochemical reactors and systems for the efficient water splitting and low temperature photo (electro) reforming (mineralization) of low cost organic compounds
- Chemical systems for highly efficient low temperature water splitting using solar radiation
- Demonstration of solar to hydrogen efficiency > 5%
- Demonstration of systems with >10,000 h lifetime (for solar water splitting processes)
- Design and construction of a reactor for providing hydrogen for consumers at low costs

Biological fermentation technologies:

- Biological hydrogen producing digestion systems based on waste or second generation biomass feedstock
- Production of hydrogen utilizing different biomass focussing on those that allow a sufficient productivity (1-10 kg/d H2)
- Develop bio-hydrogen production systems as a stepping stone for pre-commercial applications (expected to reach production rates of 10-100 kg/d H2)
- Setting up and testing of a continuous process prototype (1-10 kg/d H2)

Other Information

The consortium should include broad research and industry participation especially for material development and production with opportunities for SMEs in the field of reactor design.

Fuels that could potentially be used by animals or humans should be avoided, so as not to raise the food vs. fuel debate.

Expected duration: Up to 4 years

Funding Scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.2.7: Innovative Materials and Components for PEM electrolysers

Rationale

Electrolysis can be employed to produce high-purity hydrogen from renewable energy sources. In contrast to alkaline electrolysis, polymer electrolyte membrane (PEM) electrolysers do not require corrosive electrolytes, resulting in smaller systems that can also be operated at higher pressure. In addition, PEM electrolysers need less operation and maintenance efforts. Thus, PEM electrolysers are promising for use in small scale applications (residential homes).

In the near future, PEM electrolysers are particularly promising as a home or community-based hydrogen sources that can accelerate the early adoption of fuel cell cars. In the medium term, they would play an important role in a decentralised hydrogen infrastructure, as part of an integrated energy concept based on renewables. Overcapacities in electricity production could then be used for refuelling fuel cell cars, further encouraging earlier market penetration.

The main challenge regarding widespread use in small applications is cost reduction to increase the commercial appeal of such generators. Low-price domestic electrolysers can be achieved through high production/sales volumes, but only after economical, efficient and durable prototypes have been attained. While materials originate over 70% of the stack costs, the commercially available electrode and membrane materials have not been optimised for electrolysis operation.

Overall project objectives / Scope of Work

Systematic materials research is necessary to reduce the total life cycle costs related to current PEM electrolysers. Since materials account for about three quarters of the stack cost, production costs can be decreased considerably by replacing current commercial materials for membranes, catalysts and bipolar plates with low cost materials.

Furthermore, increased efficiency reduces running costs, thus leading to competitive overall costs. This may be achieved by:

- More efficient catalysts for the oxygen evolution reaction presenting lower activation overpotential as well as new catalyst structures or metal alloys resulting in lower noble metal loadings
- Polymer membranes with improved conductivity, low gas crossover and high mechanical stability at operating conditions such as hydrocarbon membranes or other novel membrane concepts, including composite structures
- Alternative materials for bipolar plates and current collectors, replacing the use of titanium as construction material, e.g. novel coatings for stainless steel capable of withstanding potentials up to 2 V and pressurised oxygen

Expected Outcome

- Innovative materials and components for PEM electrolysers with lower life cycle costs, achieved by enhanced efficiency determined by applying commonly agreed and validated testing procedures and test protocols and/or analysis-proven lower costs

- Demonstration of a prototype PEM electrolyser, utilising the enhanced materials and components, with the following targets:
    - Hydrogen production capacity > 1 Nm^3/h
    - Electrolyser efficiency of 75% (LHV) at rated capacity
    - High pressure operation (up to 10 MPa)
    - Voltage increase < 15 μV/h at constant load
    - Stack cost <2.500 €/Nm^3 H_2 in series production
- Development and experimental validation of testing procedures and test protocols applicable to PEM electrolyser to determine performance (e.g. power output, efficiency) and endurance. An effort to develop AST protocols for electrolysers should have high priority

Other Information

The consortium should include broad research and industry participation, from material development to system design, and production opportunities for SMEs.

The consortium should interface with appropriate bodies and organizations experienced in experimental validation of testing procedures and test protocols and/or in drafting of codes & standards.

Expected duration: Up to 4 years

Funding Scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.2.8: Pre-normative research on design and testing requirements metallic components exposed to H2-enhanced fatigue

Rationale

Exposure to hydrogen, especially at elevated pressure, enhances the susceptibility of most metals to fatigue, including those identified as fit for hydrogen service at regular ambient conditions. Vessels in composite materials are exposed to this phenomenon as well as metallic pressure vessels due to the metallic components included (e.g. load sharing or non-load sharing metallic liner in type III cylinders, metal boss in type IV cylinder). The susceptibility to hydrogen enhanced fatigue requires particular attention for stationary applications where the system could be subject to a very large number of cycles (compressor pulsation buffer, fuelling station buffers).

The fact that crack propagation in hydrogen service can be accelerated by one or two orders of magnitude compared to service in air implies that one may hardly rely on the conventional inspection approach consisting in locating cracks and acting before they reach a critical size.

Specific design requirements need therefore to be defined for ensuring fitness for service of pressure vessels subject to a large number of pressure cycles in hydrogen service.

Overall project objectives / Scope of Work

- Develop the rationale for optimised design requirements, design testing, and field inspection to ensure fitness for service of metallic sub-systems subject to cyclic fatigue in hydrogen service
- Characterise commonly used materials, such as steel alloys, for the application of the rationale developed
- Have the design and testing rationale as well as the material behaviour data recognised for demonstration of regulatory compliance to pressure equipment regulation

Expected Outcome

- Design code for pressure equipment with metallic components in hydrogen service having a structural function or a hydrogen confining function
- Metallic material characterization for hydrogen service
- Experimental implementation of design approach and design testing approach
- Proposed approach for standardisation
- Recommendations for implementation in international standards

Other Information

The consortium should include component suppliers, component testing entities, hydrogen system integrators or operators, and involve standardisation experts.

Expected duration: Up to 3 years

Funding Scheme: Collaborative Project

<u>Topic SP1-JTI-FCH.2011.2.9: Measurement of the quantity of hydrogen delivered to a vehicle</u>

Rationale

Accurate and controlled measurement of the quantity of hydrogen transferred during vehicle refuelling is required for commercial operation of fuelling stations. However, currently applied metering technologies generally do not comply with the accuracy typically specified by weights and measures authorities.

Overall project objectives / Scope of Work

- Development and testing of measurement system of the quantity transferred having a level of accuracy acceptable by weights and measure authorities. The work could either focus on improvement of existing technologies and/or on the development of new concepts
- The scope includes obtaining acceptance by regulatory bodies

Expected Outcome

- Overview of the state of the art, determination of achievable accuracy, and identification of potential technologies that could be implemented
- Overview of the legal requirements applicable in Europe to quantity measurement system used in commercial fuel dispensing applications
- Evaluation of the feasibility of meeting existing requirements
- Design and manufacturing of hydrogen quantity measurement system that can be implemented at hydrogen retail stations in commercial service
- Testing and validation of the developed system with authorities
- Recommendations regarding the adaptation of the existing regulation for coverage of hydrogen dispensing

Other Information

Project consortium should include a refuelling technology supplier, a metrology expert, and a testing facility.

Expected duration: Up to 3 years

Funding Scheme: Collaborative Project

APPLICATION AREA SP1-JTI-FCH.3: STATIONARY POWER GENERATION & CHP

TARGETS:

A set of targets for the efficiency, lifetime and cost of the main FC technologies has been indicated in the following table as a reference for the expected outcome of any topic of the Stationary Power Generation & CHP area for the AIP 2011. Other specific figures that are included in the topic description represent an integration to the table below.

Targets				
	MCFC	SOFC	PEMFC	AFC
Efficiency	> **47 %** (at MW class level) (based on natural gas)	> **50** % (at 10+ kW class level) *(based on natural gas)*	> 50% (based on pure hydrogen) (35% based on integrated reformer solution)	> **58%** by 2015 *(based on hydrogen)*
Lifetime	> **25,000 hrs** (stack) > **10 years system**	> **25,000 hours** (stack) > 10 years system	>10,000 hours (stack) >20,000 hours (system)	> **16,000 hours** by 2015 (stack) **25 years** plant life
Cost targets	**3,500 — 4, 000** €/kW by 2015 **2,000 -2,500** €/kW market entry requirement *(stack + BoP)*	**< 1000 €/kWe** by 2015 *(stack cost, 10+ kW unit size, MW manufacturing scale)*	**< 3000 €/kWe** (hydrogen fuel cell system)	**850 €/kWe** by 2015 (*for the system*)
	Meeting market requirements			

Topic SP1-JTI-FCH.2011.3.1 Next generation stack and cell design

Rationale

Break-through oriented research on novel architectures for cell and/or stack design to provide step change improvements over existing technology in terms of performance, endurance, robustness, tolerance to contaminants and cost targets for relevant applications.

Overall project objectives/Scope of Work

Novel and break-through design solutions for cells and stacks are required to show significant improvement over incumbent designs, mainly regarding efficiency, cost, reliability (and power density). The call is open to all solutions or operating ranges, geometries or materials. The project proposals should state improvements over the state-of-the-art and lead to a proof of concept.

Projects are expected to cover a range of objectives from among those listed below:

- Simplification of design and manufacturing of cells, stacks and/or stack modules (power generation units)
- New architectures, adaptation of cell and/or stack designs to specific applications and system designs
- New materials and/or strategies to improve tolerance to contaminants (e.g. sulfur species)
- Design to cost
- Significant increases in performance, power density, efficiency and/or reliability applying harmonised test protocols
- Robustness to cycling and transient operating conditions

The activities are open to all fuel cell technologies. Proposals need to identify the technology specific gaps, set the targets for critical parameters including costs, technical parameters (e.g efficiency and their improvement over the state of the art), define applications and conditions and develop a structured concept for the research activities.

Expected Outcome

Outcome will include a minimum of two of the following items:

- Improved electrical efficiency over the state of the art Considerable cost reductions consistent with market acceptance requirements for industrial or residential or other relevant applications
- Improved tolerance to contaminants with respect to state of art FCs
- Improved cycling capability of several hundred cycles from room to operating temperature with less than 5% total loss of performance
- Improved start-up time from room temperature to 30% of power rating below 1 hour
- Decreased materials consumption

- Provide evidence, physical and/or modelling based, of compactness, realistic lifetimes, cost targets and high efficiencies throughout life

Other Information

The consortium may include academia, research institutes, material producers and cell/stack manufacturers. A maximum of 2 projects are expected to be funded. Coordination with ongoing projects funded by the FCH JU is required.

The consortium should consider if the harmonised testing procedures as developed under the FP6 FCTESQA project (accessible at http://fctesqa.jrc.ec.europa.eu) can be used in addition to its in-house testing procedures.

Expected duration: Up to 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.3.2 Advanced control for stationary power applications

Rationale

Effective control of stationary fuel cell stacks is vital for optimum operation, as it influences their performance, life and reliability, as well as ultimate efficiency, fuel utilization, response times, emissions and waste. For this purpose, it is necessary to develop a better understanding of critical operating conditions and operating strategies and establish a reliable management of interfaces with the application environment. It is also necessary to develop "reliable lifetime prediction" to improve fuel cell operation for better performance and end of life extension.

Overall project objectives/Scope of Work

Projects are expected to cover a range of objectives from among those listed below:

- Development of advanced lifetime prediction methods to be integrated with advanced/adaptive control strategies able to optimise FC operations (Stack and BoP) capable of < 20% end of life degradation in simulated application environment
- Development of robust control algorithms, i.e. improving FC system performance via monitoring information.
- Development of cost efficient control methods and protocols supporting competitiveness of the fuel cell systems.
- Implementation of standard communication protocols both with control interfaces to the grid or other industrial environments

Activities need to consider relevant codes and standardisation issues (RCS) and could also take into account results from projects from previous calls in the topic "Degradation and Lifetime fundamentals" and "Operation diagnostic and control for stationary power applications".

Proposals need to identify the technology-specific gaps, critical parameters and conditions and develop a structured concept for research activities.

These activities are open to all stationary fuel cell stack types and applications.

Expected Outcome

- Improved and robust fuel cell system control algorithms and hardware
- Advanced FC lifetime prediction methods
- Development of strategies for recovery of cell and stack performance
- Control of stationary fuel cells systems in integrated generation environment to deliver low emissions and high system efficiency
- Integration of advanced control and communication modules

Other Information

The consortium should include academia, research organizations, component and stack suppliers, software developers, utilities and grid providers. A maximum of 2 projects are expected to be funded.

Expected duration: Up to 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.3.3: Component improvement for stationary power applications

Rationale

It is necessary to improve availability and cost-competitiveness of balance of plant (BoP) components, systems and sub-systems as well as their efficiency, durability and suitability for mass production to meet performance and lifetime targets.

Overall project objectives / Scope of Work

Fuel Cell related sub-system components based on developed stack designs may include:

- Power generation unit (integrated stack/ BoP)
- Power electronics
- Reforming and fuel/oxidant processing (including clean up)
- Heat exchangers/thermal management
- Air and fluid flow equipment, including subcomponents
- Fluid supply and management including pumps, turbines, compressors, valves, flow meters, desulphurisation, humidification, gas/CO2 separation systems from anode exhaust

Projects are expected to cover a range of objectives from among those listed below:

- Novel designs and optimisation of stack integration and non-stack components
- Manufacturing processes and quality control techniques for high performance and cost effective components
- Protection of fuel cell stack from contaminants emanating from BoP components (e.g. chromium release)
- Validation of lifetime, durability/robustness, corrosion rates in application specific environments
- Demonstration of ability of components to meet required life-cycle performances
- Cost assessment vs. target cost and demonstration of considerable cost reduction
- Concepts for reworking, recycling, and/or disposal including cost and environmental impact

Proposals need to identify and will be measured against technology and application specific targets: lifetime of stationary systems up to 80,000 hours, losses from balance of plant with respect to electrical net efficiency of systems:

- below 10% (including parasitic and conversion losses, e.g. from DC-AC converter), i.e. BoP electrical efficiency >90% for system < 10 kWe
- below 5% (including parasitic and conversion losses, e.g. from DC-AC converter), i.e. BoP electrical efficiency >95% for system > 10 kWe

The activities are open to all fuel cell technologies, pertinent fuels and levels of power.

Expected Outcome

Development of improved components which are:

- viable for mass production and low-cost manufacturing
- provide evidence of realistic component life and maintenance cycle consistent with system life > 10 years for large scale and up to 10 years for small scale applications and consistent with market acceptance requirements achieving cost targets using a manufacturing model with high volume manufacturing targets

Projects should identify potential for recyclability.

Other Information

The consortium should include system integrators (OEMs) and component and stack suppliers, including opportunities for academia, research organisations and SMEs in specialised areas. A maximum of 3 projects are expected to be funded. Coordination with ongoing projects funded by the FCH JU is required.

Expected duration: Up to 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.3.4: Proof-of-concept fuel cell systems

Rationale

This topic will support the development and construction of proof-of-concept fuel cell systems for any stationary application, potential feature and technology. Proof of concept systems will be constructed that show interaction with other devices required for delivering power, heat, and/or cooling, or CO_2 capture, or other possible services to end users and which will draw upon appropriate fuel supplies utilising any necessary processing technology.

This work is necessary to address the feasibility of proposed systems, prior to any further validation or demonstration activity. It will assess system performance against required functional properties, identify existing gaps and allow further development steps.

Overall project objectives / Scope of Work

Projects are expected to cover a range of objectives from among those listed below:

- Development of proof-of-concept prototype systems that combine the components into complete systems
- Integration and testing of the proof-of-concept prototype with fuel delivery and processing sub-systems; interface with devices necessary to deliver power, and heat and/or cooling or other possible services to the end user
- Identification of ways and means to meet the requirements of market competition
- Dissemination of results to industry and research
- Novel system architectures incl. new fuel processing and storage materials and processes
- Environmental sustainability assessment by means of Life Cycle Assessments studies carried out according to the International Life Cycle Data System (ILCD) Handbook requirements

The activity is open to all fuel cell technologies, pertinent fuels, level of powers and may be integrated with renewable and CO_2 sources. Proposals need to identify and will be measured against technology and application specific targets.

Expected Outcome

- Proof of feasibility of integrated fuel cell units including operation in simulated real-life context of sufficient duration (several thousand hours)
- Proof of potential to achieve targets of the specific application(s) such as system life > 10 years for large scale and up to 10 years for small scale applications, consistent with market acceptance requirements
- Increased understanding of system level failure modes leading to more robust system designs
- Definition of requirements for fully integrated systems in the specific application(s)
- Pre-normative results that can lead to recommended practice for the concept

Other Information

The consortium should include system integrators (OEMs) and component and stack suppliers and end-users, including opportunities for academia, research organizations and SMEs in specialised areas. At the end of the project, all the environmental LCA data resulting from this action shall be made available to the ILCD Data Network. Coordination with ongoing projects funded by the FCH JU is required. A maximum of 3 projects are expected to be funded. The consortium should consider if the harmonised testing procedures as developed under the FP6 FCTESQA project (accessible at http://fctesqa.jrc.ec.europa.eu) can be used in addition to its in-house testing procedures.

Expected duration: Up to 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.3.5: Validation of integrated fuel cell system readiness

Rationale

Prior to large scale demonstration, fully integrated systems must be proven at a level that shows the technology able to be developed to full scale to be technologically and economically viable; manufacturing routes need to be also identified to establish a sustainable approach towards commercialisation. Validate readiness by performing demonstration test from fuel input to power output. Other services such as heating, cooling or CO_2 capture may be included.

Overall project objectives / Scope of Work

The scope of proposals needs to reflect and must have appropriate achieved system maturity levels and a proven market potential.

Projects need to provide technical solutions for one among the main stationary application categories (domestic, commercial and industrial). They shall verify relevant technology approaches to specific applications and markets by demonstrating full systems in operation under these requirements over sufficient periods of time. In addition, they may focus on:

- Fulfilment of the diverse application needs in real environments
- Validation of the whole system build, supply chain; costs validation including end-of-life considerations
- Establishment of quality control procedures and techniques to ensure quality of systems
- Integration into real power plants and/or networks
- Maintenance and repair issues to reduce downtimes from known failure mechanisms
- Environmental sustainability assessment by means of Life Cycle Assessments studies carried out according to the International Life Cycle Data System (ILCD) Handbook requirements

The project should also seek to address relevant manufacturing solutions linked to the validation of fuel cell systems, for the specific application.

Proposals need to identify and will be measured against technology and application specific targets.

The projects will include manufacturing, the integration required and cost of hardware for the validation tests and engineering support of the test itself.

Expected Outcome

Outcomes shall include at least two among the following items:

- Validation of fully integrated systems that fulfil specifications required by the end users, including identification of mass-production route at a defined quality

- Proof of successful integration with, for instance, heat utilisation (heating and cooling), carbon capture, renewable fuels etc. and analysis of the issues these may implicate
- Operation in real-life context of sufficient duration (> 4,000 hours)
- Extrapolation of test data to longer run times pertinent to the end use and identification of failure mitigation strategies by design and/or maintenance and demonstrate consistency against market entry requirements
- Maintenance and repair strategies necessary for introduction of robust and reliable systems
- Feedback to other RD&D activities to remove technical barriers to successful larger scale demonstration
- To identify pre-normative RCS in the specific applications

Other Information

The consortium may include system integrators (OEMs), component and stack suppliers and end-users, including opportunities for academia, research organisations and SMEs in specialised areas. At the end of the project, all the environmental LCA data resulting from this action shall be made available to the ILCD Data Network. Coordination with ongoing projects funded by the FCH JU is required. The project will be coordinated with topic 3.3 for ad hoc components development and improvement. A maximum of 3 projects are expected to be funded.

Expected duration: 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.3.6: Field demonstration of large stationary fuel cell systems for distributed generation and other relevant commercial or industrial applications

Rationale

Large scale projects are required in order to contribute to the objectives of the MAIP. Those large scale projects will allow for the demonstration of use of fuel cells as a key component of distributed generation and larger industrial applications for the reduction of costs per kW, for the development of the expertise in operating and maintaining fuel cells in European regions/municipalities, increasing public awareness and attract additional candidates for further demonstration activities.

The demonstration projects shall be performed in real application environments and include interfaces with the infrastructure at least for power supply, heating, and/or cooling. Based on the end-user requirements projects can interface renewable sources, smart grids, fuel/oxidant processing or other systems as necessary. They need to be a strategic component of the energy policy of the operator so as to convince future operators, integrators etc. of the relevance of stationary fuel cells applications.

Overall project objectives / Scope of Work

Projects are expected to cover a range of objectives from among those listed below:

- Install complete integrated systems/applications with significant power generation capacity (> 100 kWe) per site
- Develop the potential for European businesses to realise supply chain opportunities
- Demonstrate integration into power, heat, and/or RES and/or smart grid, and/or CO2 capture infrastructures
- Identify improvement areas for future projects
- Estimate the full life cycle costs and revise periodically this estimate
- Show a strong commitment towards the running of the system by the operator after the end of the support phase. Note that stack changes can be sponsored as part of the project

Given that the projects will be in a real environment, they will face tight requirements, for reliability or availability, codes, standards and type approval. Therefore, they need to demonstrate sufficient level of technology readiness. Redundancy through different technologies or solution providers is encouraged in order to minimise the risks for the operator.

The activities are open to all fuel cell technologies, pertinent fuels and field of applications with relevant power generation capacity.

Expected Outcome

As part of this topic, the following objectives are defined:

- Installation and operation of at least 1 MWel (through 1 or more identical units) over more than 10,000 hours with total performance loss below 3 % will be preferred to lower installed capacity
- The opportunities to maximise European contribution to the supply chain should be addressed
- Efficiencies, cost and lifetimes which must be demonstrated through a thorough techno-economic analysis, proving achievement of the minimum performance to be reached in order to offer an acceptable initial proposition to end users
- Environmental sustainability: assessment by means of Life Cycle Assessments studies should be carried out according to the International Life Cycle Data System (ILCD) Handbook requirements
- Identification of barriers or risks to full implementation
- Public awareness: strong dissemination efforts to a wider audience, preferably to potential customers and to industrial stakeholders, shall be included

Other Information

The consortium may include system integrators (OEMs), component / stack suppliers and end-users (also electrical grid operators), including opportunities for academia, research organisations or SMEs in specialised areas. The projects may be coordinated with ongoing and upcoming projects in verification and validation and may be co-funded by national, regional or private sources in order to demonstrate a strong commitment towards the 2020 European energy policy. A maximum of 2 projects are expected to be funded.

Expected duration: Minimum 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.3.7: Field demonstration of small stationary fuel cell systems for residential and commercial applications

Rationale

Complete systems need to be demonstrated and proven to pave the ground for large scale deployment. These demonstrations must be performed in real application environment which includes interfaces with the infrastructure for power, heat, and fuel/oxidant processing as necessary in European regions/municipalities, increasing public awareness and attract additional candidates for further demonstration activities.

The number of systems needs to be significant in size in order to substantially contribute to the completion of the 2015 installed capacity objectives described in the MAIP.

In order to better address the requirements of electricity grid operators, the system design may be prepared for smart grid integration.

Overall project objectives / Scope of Work

Projects need to cover a range of objectives from among those listed below:

- Install complete integrated systems (electrical power <100kW) in sufficient numbers to build confidence by redundancy (exceeding 25 identical units in the range 1-10 kWe, at least 3 identical units for units > 10 kWe)
- Help building the supply chain and support activities for complete systems
- Demonstrate integration into existing power and heat infrastructures and smart grid infrastructures
- Demonstrate capture of heat generated by the fuel cell sub-system and deployment within the home heat and hot water systems, to show genuine CHP operation at total efficiency >85% (LHV)
- Increase the operational experience (incl. maintenance) of fuel cells in Europe
- Provide for training of personnel for installation and maintenance
- Estimate the full life cycle costs and revise periodically this estimate
- Demonstrate the commercial mass manufacturability of the designs to be trialled, including volume capable supply chain

Given that the projects may face tight reliability constraints, they need to demonstrate sufficient levels of technology readiness and capacity to meet key challenges (cost reduction curve to meet targets 2015 and 2020 indicated in the MAIP). Redundancy through different technologies or solution providers is encouraged in order to minimise the chance of failure for the operator.

As the purpose of this topic is to develop a fleet of small scale applications, investments may be significant. It is therefore required that the project describes the concept for the duration of the support program as well as the operation thereafter. For instance, the project could consist of a period of manufacturing, installation, “normal operations”, optimisation, reliability improvement and first stack change (3-4 years, supported by the call).

Expected Outcome

Successful demonstration of FC-based integrated generator systems that provide:

- Required efficiencies (minimum 35%, better >40%), cost (below 20,000 € per unit installed) and lifetimes (8 to 10 years) which must be demonstrated through a thorough techno-economic analysis, indicating the minimum performance to be achieved in order to provide an acceptable initial proposition to consumers
- Identification of barriers or risks to full implementation
- Identification of benefits and risks considering the smart grid integration
- Proof of suitable supply chain and field support concept
- Feedback to RD&D activities on required mitigations
- Environmental sustainability assessment
- Dissemination efforts to a wider audience, preferably to potential customers and to industrial stakeholders (also electricity grid operators), must be included

Other Information

A strong commitment towards the running of the system after the end of the support phase should be evident.

The consortium could include system integrators (OEMs), component and stack suppliers service providers (e.g. installation and maintenance providers) and end-users, including opportunities SMEs in specialised areas.

The project will be coordinated with ongoing and upcoming projects in verification and validation (as for instance in topics 3.4, 3.5 of the current call) and may be co-funded by national, regional or private sources in order to demonstrate a strong commitment towards the 2020 European energy policy. The consortium should consider if the harmonised testing procedures as developed under the FP6 FCTESQA project (accessible at http://fctesqa.jrc.ec.europa.eu) can be used in addition to its in-house testing procedures. A maximum of 2 projects are expected to be funded.

Expected duration: Minimum 3 years

Funding Scheme: Collaborative project

Topic SP1-JTI-FCH.2011.3.8: Pre-normative research on power grid integration and management of fuel cells for small residential, commercial and industrial applications

Rationale

Pre-normative research shall be conducted to define a whole set of requirements with the necessary specificity for different application categories. This will ensure that power grid integration and management of the main stationary fuel cells application categories (residential CHP, commercial and any industrial application) are performed according to the developing Rules, Codes and Standards to be applied for the use of such devices. Aim of CHP integration into demand side management (DSM) is to increase the efficiency of RES.

Overall project objectives/Scope of Work

Pre-normative research should focus on:

- Research into the interaction of fuel cell system, power conditioning and grid connection, including grid failure conditions, harmonics, etc.
- Research of integration of CHP fuel cell systems for demand side management.
- Review of previous and on-going RCS activities and studies (e.g. US, Japan) from which a proposal for best practices can be extracted.
- Dissemination of results to industry and research

Expected Outcome

Projects shall provide:

- Improved technical understanding of grid interaction problems
- Proposals for validation and integration protocols for DSM
- Background procedures and methodologies for RCS
- Proposal and recommendations for further development of RCS

Other Information

The consortium should include any of research and/or industry test facilities, certification agencies, OEMs, end-users and utilities with relevant expertise, including opportunities for specialised SMEs and possibly academia and research organisations Cooperation with JRC-IE (http://ie.jrc.ec.europa.eu) already active in the field of RCS for fuel cells may be considered by the consortium. Links to US activities should be explored. A maximum of 1 project is expected to be funded under this topic.

Expected duration: Up to 2 years

Funding Scheme: Collaborative project

APPLICATION AREA SP1-JTI-FCH.4: EARLY MARKETS

Topic SP1-JTI-FCH.2011.4.1: Demonstration of fuel cell-powered Material Handling Equipment vehicles including infrastructure

Rationale

The powering of material handling equipment (MHE) vehicles is a promising early market application of fuel cells and hydrogen. The technology has already been adopted, particularly in North America, by industrial end-users who have commenced fleet implementation and hydrogen re-fuelling system solutions, at the individual site level.

To promote European based technology and commercialisation of hydrogen and fuel cells for MHE, vehicles demonstration at the fleet level of the latest fuel cell technologies is required in order to prove out performance and reliability for customer acceptance and also to enable system and hydrogen infrastructure cost reductions. Demonstration projects are needed at several end-user sites/MHE applications in order to clearly show that the total cost of ownership can be appreciably reduced using a developed fuel cell technology and the demonstration focus should be on MHE applications where hydrogen and fuel cells show a clear benefit to the end user (e.g. in terms of savings, increased output, emission reduction etc.).

Overall project objectives/Scope of Work

- Projects shall focus on achieving a cost competitive Total Cost of Ownership (TCO) compared to conventional forklifts (battery, LPG and/or diesel) with the inclusion of FCH-JU support. This may be in one or several types of any MHE vehicle application where a competitive TCO can be achieved
- Projects shall be based on a fuel cell technology platform with high credibility for fleet level MHE vehicle demonstration, but where the proposed project activities will achieve or exceed cost, efficiency and durability benchmarks to provide a clear advantage to the end-user over incumbent technology
- Projects should show clear cost targets within the project for the different applications addressed, documenting a competitive TCO, as well as showing performance improvements and/or cost reductions achieved by the development work and demonstration unit volumes
- Projects shall evaluate achieved benefits (e.g. in terms of savings, increased output, emission reduction, operating hours etc.)
- Projects should contribute to the setting of clear technical targets on costs, durability and efficiency in order to establish a path forward for commercial deployment. Targets should be specific and relevant for the MHE vehicle type(s) to be developed, demonstrated and commercialised for future deployment. Indicative targets could be:
    - Total cost of fuel cell system (at early volume production): <€3,000/kW
    - System lifetime (with service/stack refurbishment): >7,500 hours
    - Fuel cell System efficiency (tank to wheel): >45%

    - Refuelling time: 3 min
    - Hydrogen price dispensed at pump (end-user price): <10 €/kg
    - Availability of vehicles & refuelling to match conventional & competing technologies
- Projects should show a solid approach for permitting and provide clear recommendations with regards to the Regulation, Codes and Standards (RCS) that are needed to facilitate permitting and commercialization of HFC technology for the material handling application(s) addressed
- The projects should be based on business plans and committed partners to continue on the pathway to volume deployment and roll-out to commercial market introduction

Expected Outcome

- Demonstration shall comprise at least 50 or more fuel cell MHE vehicles at one or across several end-users sites and applications proving a commercial customer value proposition. Demonstration should include necessary and relevant supporting hydrogen supply infrastructure
- Clear TCO evaluations for each application shall be delivered together with cost targets for formulating future deployment schemes and mechanisms
- Environmental sustainability: assessment by means of Life Cycle Assessments studies should be carried out according to the International Life Cycle Data System (ILCD) Handbook requirements

Other Information

The project consortium should be lean focusing on demonstration activities, and may include for example system developers, materials handling equipment providers, technology providers and support for permitting and RCS development, fuel suppliers, end-users or other relevant types of actors. They should focus on the maximum number of MHE vehicles for demonstration e.g. by pooling of several end-users through joint project constellations. The project should be coordinated with material handling demonstration projects funded under previous 2009 and 2010 calls.

Expected duration: Up to 5 years

Funding Scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.4.2: Demonstration of application readiness of Back-Up Power and Uninterruptible Power Systems

Rationale

Back-Up Power (BUP) and Uninterruptible Power Systems (UPS), together with base load power supply, are promising early market applications for fuel cells and hydrogen and these technologies are being taken up by end-users in the telecoms, utilities, IT and other industry sectors. The potential to move into formal system implementation in the field is driven by the Total Cost of Ownership (TCO) gains resulting from the substitution of diesel gensets and batteries by hydrogen fuel cells. These gains can be very significant in areas where grids are unstable (Asia, Africa, etc) but are still significant in Europe where grid networks are quite stable.

To promote European based technology commercialisation of hydrogen and fuel cell solutions for BUP and UPS applications (and where applicable base load power systems) needs to be demonstrated at representative end-user sites and against specific end-user requirements to show that acceptable performance, reliability and lifetime targets can be met and that a lower total cost of ownership can be achieved.

In the telecom sector the trend is for a reduced power requirement per site and 1-3 kW scale BUP and UPS systems are becoming more prevalent. However, site consolidation is also occurring with multiple operators co-locating their equipment and using the same BUP or UPS system, and providing base power for all system requirements. The major part of the market can be reached with solutions up to 10 kW but TCO gains for fuel cells might be found for systems of up to 50kW in off-grid applications.

Overall project objectives/Scope of Work

The overall objective is to deploy BUP or/and UPS units that can show a cost competitive total cost of ownership (TCO) when compared to legacy solutions (battery and diesel generators). The demonstration focus will be in the power requirement range of 1-10 kW or up to 50 kW on an exceptional basis. Fuel cell BUP and UPS demonstration sites could include more than one power range and type of fuelling solution (hydrogen logistics or on-site reforming of multiple fuels as well as integration with renewable sources where available). Projects need to:

- Utilise latest development pathways (at the component and full system level) to establish technology platforms with improved reliability, life-time and cost prediction that already show credibility for future volume manufacture and roll-out, and providing a demonstrable advantage to the end-user over incumbent technology
- Measure and evaluate achieved benefits (e.g. in terms of savings, maintenance, emission reduction, operating hours)
- Contribute towards the determination of clear technical targets on costs, durability and reliability in order to establish a path forward for commercial deployment
- Provide for training of personnel for installation, fuelling, maintenance and service
- Provide clear recommendations for the establishment of the Regulation, Codes and Standards (RCS) framework needed to permit and to facilitate the commercialization of HFC technology for the application(s) addressed

- Be based on business plans and committed partners to continue the transition to volume deployment and future market introduction
- Disseminate results to wider audiences, preferably to potential customers and to the application stakeholders

The fuel cell systems to be demonstrated will need to meet key challenges resulting from increased operation such as LHV average electrical efficiency of 50% (35% for reformate based fuel cell systems) and > 1,000 cycles capability. Ideally one scalable system technology can be used to address a broad range of power requirements so as to simplify service and maintenance and to minimise spare parts inventory.

Expected Outcome

- Demonstration shall comprise a sufficient number of sites and a sufficient number of systems (for example up to 20 in the 1-3 kW range, 10 in the 6-10 kW range or 5 systems in the 11-50 kW range) in order to prove a technology solution and commercial customer value proposition thereby leading to a strong potential for future commercial supply without support
- Technical requirements that the proposed systems should include:
  - Reliability >95%
  - Response time of less than 5 ms
  - Projected lifetimes of 3 to 5+ years
  - Target system cost: 3,500 €/kW (if fuel cell system alone is considered); 6,000 €/kW (if fuel cell system + hydrogen generator is considered)
  - Projected number of start-stop cycles 2,000
- Demonstrate a viable hydrogen supply solution for this application
- Demonstration activities should ensure the continuation of efforts in large scale deployment projects and/or market introduction
- Environmental sustainability: assessment by means of Life Cycle Assessments studies should be carried out according to the International Life Cycle Data System (ILCD) Handbook requirements

Total cost of ownership evaluations for each application shall be delivered together with cost targets for formulating future deployment schemes and mechanisms.

Other Information

The project consortium should include a mix of sector relevant end-users (telecoms and other applicable industry sectors), equipment OEMs or/and service providers, fuel cell system developers and fuelling infrastructure or fuelling replenishment providers, alongside research organizations (testing) and certification agencies.

The delivery of BUP or/and UPS units for field demonstration should be achieved within one year of project commencement. Proposals should indicate a clear commitment of end users and/or service providers to continue with fuel cell system commercialization and technology deployment in Europe or external market regions post project completion.

Expected duration: up to 3 years

Funding Scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.4.3: Research and development of 1-10kW fuel cell systems and hydrogen supply for early market applications

Rationale

Further development efforts are needed to create market competitive fuel cell systems in the 1kW to 10 kW range that reduce cost and improve performance, efficiency and durability of fuel cell systems and hydrogen supply routes for applications such as back-up power, UPS and material handling equipment. The development efforts are to focus on reaching targets that enable a commercial market use.

Overall project objectives / Scope of Work

Development of new generation high performance, durable and cost-effective fuel cell systems in the 1-10kW power range for early markets such as back-up power, UPS and material handling equipment. Full concepts across the entire value chain should be pursued both addressing fuel cell system and hydrogen cost.

Emphasis should be on development efforts that help:

- Reduce cost of the fuel cell system by optimization of Balance of Plant components (fewer and more efficient components e.g. air/hydrogen compressors, multipurpose components/vale blocks)
- Improve efficiency of the fuel cell system by optimal hybridisation (e.g. increase of breaking power utilization through use of batteries and/or super capacitors)
- Reduce cost of hydrogen by new innovative supply concepts (e.g. onsite or integrated production or new distribution methods)

The following main elements should jointly be addressed within the same project:

- Hydrogen supply including either distribution or onsite-production concepts
- Fuel cell systems, balance of plant components and hybridisation / power management

Expected Outcome

Projects should develop and conduct laboratory testing of new fuel cell system prototypes and hydrogen supply components, verifying reaching of the below listed 2015 targets that enables a full commercial use. At least one of the below listed markets should be addressed by a project, and if justified several applications may be addressed within the same project. Accomplishing or exceeding this list of targets for at least one addressed market have to be demonstrated on at least one prototype.

<u>Heavy duty material handling vehicle targets</u>

- Hydrogen cost at point of consumption <€7/kg
- Fuel cell system cost <€1,500/kW (@ >1,000 units)
- Fuel cell system efficiency >50%

- Fuel cell system life-time 15,000 hours (fuel cell stack 10,000 hours) – with regular/cost effective maintenance/refurbishment

UPS/Back-up-power – (short and not frequent blackout) targets

- Hydrogen cost at point of consumption 30€/kg
- Fuel cell system cost €1,500/kW (@ >500 units)
- Fuel cell system efficiency 40%
- Fuel cell system life-time 5,000 hours (fuel cell stack 2,000 hours)

UPS/Back-up-power – (long and frequent blackout) targets

- Hydrogen cost at point of consumption: not applicable because in this case hydrogen generator should be included
- Fuel cell system cost €2,500/kW (including H2 generator) (@ >500 units)
- Fuel cell system efficiency 50% with direct hydrogen and 35% when working with an integrated reformer solution
- Fuel cell system life-time 10,000 hours (fuel cell stack 10,000 hours)

Projects should further detail the above targets in the proposal showing that these on a total cost of ownership basis enables a commercial use in the markets addressed. Also proposal must define their state-of-the-art level, current bottlenecks, the specific progress to be achieved within the project and the development approach to achieve these targets. A roadmap to mass production with intermediate commercial targets through volume build-up shall be delivered.

Other Information

Consortia should include relevant partners to ensure sufficient coverage of the value chain behind the product application(s) and their markets, e.g. research organisations, component suppliers, system integrators and product OEMs. Consortia should be capable of showing a committed development and business approach and to the markets and products in focus, both providing a strong past track-record of activities as well as dedicated efforts and plans to further commercialise and market introduce the products.

Expected duration: Up to 3 years

Funding Scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.4.4: Research, development and demonstration of new portable Fuel Cell systems

Rationale

Europe has only a very narrow technology base in portable fuel cell systems and related fuelling options, which limits opportunities to address a wide number of early market segments which have been shown elsewhere to be attractive for early commercial introduction, such as:

- Construction site tool recharging
- emergency and/or remote power
- Powering recreational applications (for camping, caravanning, boating etc.)
- Personal portable power / powering consumer electronics
- Educational devices

Development of portable power technologies would also potentially overlap into applications such as powering autonomous airborne and ground vehicles and small auxiliary power units for vehicles, particularly if the fuelling capability extended across the fuel spectrum to include conventional and renewable liquid fuels.

SME led consortia capable to build prototypes combined with the expertise of research institutions, driving developments of new application specific prototypes with a focus on performance and cost improvement and design for manufacture to reduce material and assembly costs will be a primary programme focus. Dissemination across sectors and development of a European supply chain will strengthen the European portable fuel cell industry, its technical expertise, design for manufacture and production pathways towards future volume production of portable fuel cell systems.

Overall project objectives / Scope of Work

The topic shall be open to all types of fuel cell technology (low and high temperature) and related key components, provided they can sufficiently demonstrate their ability to meet application and user specific requirements using any suitable (including logistic) fuel source. Electrical power output should be between 50 W and 500 W_e. If possible and applicable, intelligent use of waste heat is recommended.

The objective is to develop complete systems, ready to be used by specified end users. Thus the system development may include:

- stack
- fuel storage
- if required fuel processing
- balance of plant components
- if required for the application, power electronics and controls integration

Projects should provide clear recommendations for the establishment of the Regulation, Codes and Standards (RCS) framework that is needed to facilitate the commercialization of these micro fuel cell technologies

Where appropriate and technically feasible, the system shall be designed on a modular basis to allow scale-up and scale-down for a wider range of application requirements.

Expected Outcome

- Proof of concept systems containing stacks, all balance of plant components and fuel supply meeting application specifications
- Demonstrate system operation with electrical efficiencies of 30%+ (based on a logistic fuel input)
- 1,000 h lifetime including 100 start-stop cycles and specific size and weight of less than 35 kg/kW and 50 l/kW (fuel amount excluded)
- System validation through systematic and widely agreed testing protocols/activities, demonstrating a cost prediction for mass production of less than 5,000 €/kW

System prototypes should be developed and demonstrated at the proof of concept level within the project (lifetime demonstration might be completed after the project). All components must be capable of operating in the temperature range between -20 and +60 °C. Final systems may be flexible for application in several markets to reduce commercial risk and aggregate for reduced cost of production / assembly and market entry. Costs of mass manufactured final systems should be identified in conjunction with end-users or from using commercially experienced production specialist sources.

Other Information

The consortium should include research and development partners for new ideas, sufficient industrial capacity for commercialization, and at least one end-user / system integrator as a consortium partner as well as support for RCS development. The proposal should cover a mix of RTD, proof of application specific concept, and proof-of-concept demonstration of the application specific technology. Involvement of innovative SMEs is strongly encouraged. End-user(s) should be involved throughout the programme from setting the targets until the market outlook for the specific application, influencing the early design stages, system validation and testing activities, which may be conducted in research organizations/facilities.

Expected duration: Up to 3 years

Funding Scheme: Collaborative Project

Topic SP1-JTI-FCH.2011.4.5: Research and development of Balance of Plant items for small portable and other fuel cell devices

Rationale

Small portable and associated mobile or stationary fuel cell systems in the 50 W – 500 W power range lack balance-of-plant (BoP) components, which are not readily available within the European (or global) supply chain and which impacts system specification compliance, performance, lifetimes and impacts European system suppliers cost competitiveness. It also restricts early market introduction of small portable and other fuel cell systems. As the stack costs are typically 1/3 of the fuel cell system costs, the other 2/3 of costs need specific attention to achieve cost reduction targets and payback times.

Overall project objectives / Scope of Work

Development of appropriately scaled BoP is needed in order to achieve required system power densities and to meet target costs. Projects should therefore cover all research and development steps required to achieve marketable products, including durability testing under realistic conditions and integration and tests in fuel cell systems.

The following key components are covered by the scope of the call although other components which can be shown to have a significant impact on system performance, lifetimes, safety and costs may be considered:

- Mass flow meters for air and gaseous fuels
- Liquid dosing pumps
- Air blowers
- Filling level indicators

Expected Outcome

The components must be capable of operating in the temperature ranges typical for small portable and other fuel cell devices (usually between -20°C and +60°C) and have a lifetime of at least 1,000 h should be developed and demonstrated at the proof of concept validation level within the project with mid-term target of 3,500 h. Low voltage power supply and power consumption is mandatory.

The components should meet the following technical targets:

- Mass flow meters for air and gaseous fuels should provide an accuracy of less than 5% of the measured value, a pressure drop less than 2 mbar at a flow rate of 20 l/min for air and a power input of less than 30 mA
- Liquid dosing pumps; emphasis is on pumps with a back pressure of more than 2 bar at flow rates lower than 1 l/h, a power input of less than 200 mA and a space demand of less than 100 cm^3 at a weight of less than 100 g

- Air blowers; emphasis is on high performance blowers with a back pressure of more than 45 hPa at flow rates of 50 l/min or higher a power input of less than 30 W and a space demand of less than 400 cm^3 at a weight of less than 300 g
- Filling level indicators should be continuously and suitable for de-ionised water; power consumption should be less than 0.1 W at a weight of less than 40 g

The price targets (corresponding to a production number of 1,000 units/y) to be met are <50 € for mass flow meters and level indicators and <75 € for pumps and blowers. At least 10 units of BoP components have to be delivered and tested by the system integrator. The system integrator shall confirm the component quality and fit into the final system.

Other Information

Project consortium are expected to include SME and other component suppliers, development and test facilities, and at least one system integrator or/and an end-user with sufficient industrial capacity, or access to such capacity, for future commercialisation.

Expected duration: Up to 3 years

Funding Scheme: Collaborative Project

APPLICATION AREA SP1-JTI-FCH.5: CROSS-CUTTING ISSUES

Topic SP1-JTI-FCH.2011.5.1: Assessment of benefits of H2 for large scale energy storage and integration in energy markets

Rationale

Hydrogen is recognised for featuring good energy density in terms of mass, which clearly allows its use in various portable, mobile and small scale applications in the range up to the tens of kWs, despite other technical difficulties. The also good energy density in terms of volume could also be valuable in the upper range of the MWh to GWh scale in situations where an energy buffer is needed in an energy system. So far, hydrogen is systematically less favoured as a potential solution against other possibilities, such as hydro pumping, CAES or advanced batteries because of its lower round trip efficiency. In parallel to an increased R&D effort in the field of electrolysis and demonstration projects to show technical feasibility, an effort should be made to highlight the advantages of hydrogen as massive energy buffering at the energy system level, especially taking into account the rising share of renewable electricity as well as the limited capacities for conventional storage options. The hydrogen produced could serve not only for electricity generation, if economical break-even can be attained, but also as a source of renewable hydrogen for mobility or stationary applications.

Overall project objectives / Scope of Work

The project has to bring hydrogen to the forefront of the discussion on large scale energy storage, either centralised or decentralised, giving sound and clear indications to the energy actors and markets on where the advantages and the limitations are, and show with practical data potential successful applications of the concept at the regional or European energy system level. In addition the different storage options in geological formations (e.g. salt caverns, aquifer formations or depleted gas fields) as well as the geotechnical potential all over Europe should be evaluated.

The work should be directed to compare the technical and economic performance of hydrogen as massive energy buffering at the energy system level, either centralised or decentralised, find the restrictions to the practical application (i.e. the need of a geological site for underground seasonal storage, lack of technical equipment to provide safety comparable to common underground natural gas storage, lack of regulations/RCS, etc.), define viable situations where hydrogen adds value in an energy market, set timelines for these situations, pave the way for demonstration projects, target the interest groups and communicate the findings.

The work methodology, especially for the technology comparison, has to prove neutral and consistent.

Expected Outcome

- Benchmark study of the various energy buffering alternatives valid for GWh scale over days to weeks, addressing cost per power and per energy for various scenarios (short term vs long term applications)
- Assess storage options in geological formations (e.g. man-made salt caverns, natural aquifer formations or depleted gas fields) in terms of suitability, capacity, costs, state of the art and derive recommendations to demonstration projects or pilot scale experience
- Evaluate availability of suitable geological formations for the recommended storage options all over Europe
- Evaluate the added value of hydrogen as energy buffer related to the energy market and its commodities, identify market mechanisms (existing or not) and regulatory gaps (RCS), and exemplify in potential (but credible) business cases
- Estimation of energy management by modelling
- Assessment of environmental issues
- Set recommendations on future projects for technology evaluation, demonstration or pilot scale
- Identify the interest groups, establish a communication plan and execute it

Other Information

The consortium should include or guarantee robust liaison to relevant agents of electricity and gas markets as well as engineering companies specialised in underground gas storage, including companies, system regulators (including RCS) and market regulators.

Expected duration: 2 years

Funding Scheme: Coordination and Support action

Topic SP3-JTI-FCH.5.2: Study of Financing Options to accelerate commercialization of hydrogen and fuel cell technologies

Rationale

A number of components from fuel cells can be recycled or recovered for later use in new products. The ability to do so should impact the upfront cost of the fuel cell stack, because cost can be spread out over several generations of fuel cells. The most obvious example is Pt, a component that by some estimates accounts for up to 50% of the cost of the fuel cell stack. As a commodity on the open market it is also subject to significant oscillations in price. These could be diminished if its costs were spread out over several uses, thus reducing the stack cost significantly. This model may be applied to other components of PEM fuel cells and even other types of fuel cells. However, proper financing mechanisms to achieve such a scenario have not been explored and are thus necessary.

Overall project objectives/ Scope of Work

The study should take into account suitable recyclable or reusable fuel cell components for which proposed mechanisms would apply. It should analyse in detail the impact of proposed solutions on the upfront cost of fuel cell stacks and systems and how it these would advance commercialisation. It should develop financing mechanisms that take into consideration these recoverable costs and are able to reduce them significantly. The study should also consider the feasibility of implementing such measures including, but not limited to, from a legal and financial point of view.

Expected outcome

- Analysis of the potential recyclable components of fuel cells
- Development of models for financing costs of components over several years
- Analysis of effects on factory cost and end user prices
- Study on possible structures required to make proposed mechanisms feasible (legal, regulatory, financial)

Other information

The consortium should contain at least one major supplier for the fuel cells market, financing and/or commodity market specialists, experts on automotive cost calculations and pricing as well as organisations with legal expertise.

Expected duration: Up to 1 year

Funding Scheme: Coordination and Support Action

<u>Topic SP1-JTI-FCH.2011.5.3: First responder educational and practical hydrogen safety training</u>

Rationale

Hydrogen applications are being demonstrated as a viable economical solution that will take an important place to solve the energy challenges of the 21st century. Projects with Hydrogen Energy storage chain coupled with renewable sources, hydrogen powered vehicles and refuelling stations are being deployed throughout all Europe.

While hydrogen applications are being introduced into the market, fire services awareness and knowledge regarding these new technologies is low. To facilitate hydrogen local project approvals, it is essential to provide them solid theoretical and practical training since they will inevitably face accidental situations during which they will need to know how to respond adequately to protect the public without putting in jeopardy their own life.

Practical training must be provided during full scale accidental scenario exercises taking place in hydrogen Energy storage site and hydrogen refuelling stations with hydrogen powered vehicles. Best practices based on exercises feedback must be disseminated using online tools.

Overall project objectives / Scope of Work

- Support the successful implementation of hydrogen and fuel cell demonstration projects and market transformation by providing educational and practical hydrogen safety training to Fire Services and site operators, who must know how to handle potential incidents; their understanding can also facilitate local project approval

Expected Outcome

- Develop and disseminate first-responder hydrogen safety educational materials in Europe
- Build and disseminate hydrogen safety response approach based on feedback and responders' best practices
- Develop and disseminate first-responder intervention guide
- Install an European Hydrogen Training Platform on which will be realised full scale exercises
- Perpetuate practical training using the platform disseminate best practices using online tools
- Facilitate hydrogen local project approvals in Europe

Other Information

The consortium should include a full scale training platform that can reproduce all fire service commandment chain, web-site training software, academic partner, RCS experts and Europeans Fire Service institutions.

The hydrogen mock up vehicle, refuelling station and hydrogen energy storage chain coupled with renewable energy sources that will be supplied shall be identified. Projects may be coordinated with other cross cutting projects.

Expected duration: Up to 3 years

Funding Scheme: Coordination and Support Action

Topic SP1-JTI-FCH.2011.5.4: Development of industry wide uniform performance test schemes for PEM fuel cell stacks

Rationale

Successful application of fuel cells in real world conditions requires reliable assessment and prediction of performance and durability observing environmental compliance and safety aspects. To facilitate the interaction of stack developers, system integrators and end-users, as well as technical development and to assist in the drafting of European and international codes & standards, commonly accepted testing procedures and test protocols representing the most relevant application areas of PEM fuel cell stacks need to be developed and agreed upon among the stakeholders using state-of-the-art expertise and consolidating typical test schemes by experimental verification.

Overall project objectives / Scope of Work

The project shall identify the most relevant testing procedures and test protocols addressing performance and endurance while ensuring compatibility with safety requirements and - where existing - regulatory aspects in typical applications of fuel cells especially automotive & light traction, materials handling, leisure, as well as auxiliary and backup power. Testing procedures and test protocols commonly agreed upon by all stakeholders shall be developed to a level readiness for use in industrial technology assessment and – if accepted by relevant standard developing organizations (SDO) – to be taken up into codes & standards.

The procedures and protocols should allow reliable prediction of stack behaviour based on relevant operating parameters, include descriptions of the required test bench infrastructure and test set-up, and provide a methodology for uniform collection, analysis and presentation of test data as well as results. The developed procedures and protocols are to be experimentally validated preferably by round robin exercises.

Specifically, the procedures and protocols should at least address:

- Performance under typical operating conditions including startup and shutdown as well as foreseeable irregular operating conditions
- Durability under load following, dynamic cycle testing including periods of low or no load in accordance with application requirements
- Exposure to regular and harsh environmental conditions (surrounding temperature, pressure & humidity, shocks & vibrations, saline atmospheres, etc.)
- Accelerated lifetime tests in respect to durability and degradation
- Efficiency tests
- Safety tests

The project should draw on the experience gained in previous 5th and 6th Framework Programme projects (e.g. FCTESTNET, FCTESQA, FUERO, DECODE) and of ongoing FCH JU projects. Establishing liaison to SDOs, for example the Technical Committee 105 of the International Electrotechnical Commission (IEC TC 105) and/or to the Technical Committee 22 of the International Standardization Organization (ISO TC 22) as well as representative organizations (e.g. international/regional/national and SDO) for different application areas is encouraged.

Expected Outcome

- Identification of the most relevant testing procedures and test protocols for particular fuel cell applications
- Definition, development and experimental validation of commonly accepted testing procedures and test protocols for a selected number of fuel cell applications
- Establishment of methodologies for the uniform collection, analysis and presentation of test data
- Description of the required test infrastructure (test benches, system environments, hardware in the loop installations etc.)

Other Information

The consortium should have a balanced representation of academia & research, stack system developers and OEMs as well as of testing organizations. The consortium should interface with relevant other projects as will be identified during the course of the project or upon FCH JU request.

The consortium should interface with the relevant SDO (standard developing organizations) and – upon request – assist in the development of relevant standardization efforts.

Cooperation with JRC-IE (http://ie.jrc.ec.europa.eu) which is active in the development and experimental validation of fuel cell testing procedures is to be considered by the project consortium.

Expected duration: Up to 3 years

Funding Scheme: Collaborative Project

3.7 Public Procurement: Benchmark Studies

As part of the AIP2010, three tenders were identified. These public procurements referred to commercialisation studies for various applications of hydrogen and fuel cell technologies. The launching of these tenders is foreseen for Q3 2011, with contract signature before the end of 2011. Prior to the launch, the FCH JU will work with industrial stakeholders to identify more specifically the areas of interest for each study.

The activities described in this section fall outside of the mainstream 'calls for proposals' means of implementation of the Annual Implementation Plan. Funds will be made available to support the following activities:

- **One public procurement** - planned for 2011 as shown in the table below:

Subject (Indicative title)	**Indicative** **FCH JU Funding €**	**Indicative timetable for publication**
Development of a European commercialisation strategy for fuel cell stationary applications	One contract 1.5 million	Last quarter 2011
Total indicative FCH JU Funding[31]	**1.5 million**	

The main objective of this European commercialisation strategy is to establish an independent fact base for fuel cell technology in Stationary Applications, as well as a European based roll out plans.

Tenders shall be carried out under a direct service contract as defined in the Directive 2004/18/EC[32]. For the award of the contract an open procedure shall be used. A contract notice with reference to detailed tender specifications shall be published in the S series of the Official Journal in line with preliminary timetable indicated above.

[31] The amount corresponding to EFTA contributions (2.38% of budget) may be used to reinforce the different sub-budgets.

[32] DIRECTIVE 2004/18/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:134:0114:0240:EN:PDF)

4. Horizontal and Support Activities

4.1 Policy and Communication

Fuel cell and hydrogen technologies are of key importance for tackling energy, transport and low carbon challenges as highlighted in the European strategic orientations such as the Europe 2020 strategy. They are also instrumental in delivering benefits to the public and society in relation to energy security & efficiency, green mobility and air quality in urban centres to name a few.

Yet these technologies are still relatively unknown to the general public, whereas policy makers are not familiar with their deliverables and potential.

The wide benefits of these technologies and the RTD and demonstration results obtained within the Joint Undertaking must therefore be fully advocated and widely disseminated.

All the more since major sector specific strategies- relevant for the development and deployment of fuel cells and hydrogen technologies- derived from the Europe 2020 strategy are the basis for allocation of funds over the next Multi-Annual Financial Framework (2014-2020), including budgets to support research and innovation.

For these reasons, efficient and pro-active communication and dissemination activities are of particular importance for the success and positioning of the FCH JU.

The overall objective is to ensure political and public awareness:

- through active promotion of (1) the benefits of Fuel cells and hydrogen technologies and (2) FCH JU activities, making them more visible and understandable to different audiences in order to gain acceptance and support
- So that the FCH JU is perceived as a key European strategic initiative for focused, coordinated and competitive RTD activities in the field of fuel cells and hydrogen

Strategic objectives are to:

- Ensure internal communication and coordination with members and stakeholders managing their expectations and promoting continued interest in the FCH JU activities
- Engage external stakeholders encouraging increased RTD investment in fuel cell and hydrogen technologies

To deliver these objectives, the FCH JU has identified and is monitoring policy initiatives related to FCH activities through effective involvement with policy makers in EU institutions (notably Commission and Parliament) but also at national and international level) with a view to advocate on the technologies and FCH programme.

A long term communication strategy for the FCH JU will be adopted in 2011 to ensure proper messaging and outreach to stakeholders and the public.

The FCH JU intends to reinforce its communication activities in 2011, implemented by the Policy and Communications Officer and the Stakeholder Relationships Manager on one hand and Project Managers and Executive Director on the other hand:

- establish an effective and regular dialogue with stakeholders and selected target audiences to increase awareness and acceptance for FCH technologies

- share information, expertise and experience
- communicate and disseminate information on the projects and programme
- coordinate all relevant stakeholder groups on program activities and communicate with other platforms and initiatives

As a key communication tool, the FCH JU has redesigned its website[33] which is now hosted outside the Europa environment and fully managed and maintained by FCH JU. It includes a clearer architecture and a better user-friendly navigation, while highlighting key information about the programme and call for proposals, news and events. Furthermore, the website will be instrumental in disseminating project information and results.

The FCH JU is also reinforcing its branding and visual identity and is developing communication products to be distributed such as leaflets, brochures.

The Stakeholders General Assembly 2011 will also be an important channel for communication and information exchange on FCH JU activities. The SGA will be organised in relation with a review day to publicly assess the progress of the programme towards its objectives.

Activity/event	Timing
Policy monitoring and advocacy	Q1-Q2-Q3-Q4
Call for Proposals 2011 related public and press relations	Q2-Q3
Development of communication products and visual identity	Q2-Q3
SGA - Stakeholder event 22-23 November 2011- Review day	Q3-Q4

4.2 Other support activities

Finance and Administration

Finance and Administration is a major component of Horizontal and support activities which main objective is to ensure the Programme Office can efficiently carry out its operational mandate.

The Finance and Administration Unit includes Finance and Budget, Human Resources, General Administration, Legal and IT. It also covers the internal control coordination which comprises notably monitoring the follow-up on action plans regarding implementation of internal control standards and on results of audits and coordinating the preparation of the Annual Activity Report.

Finance and Budget

[33] http://www.fch-ju.eu

The main objectives for Finance and Budget are to ensure a sound financial management of the Programme Office resources and compliance with the FCH Financial rules and procedures.

Main activities include the following:

- allocate budget resources in line with planned activities
- establish the necessary commitments to ensure the timely availability of resources for the speedy implementation of all operational and support activities
- execute the necessary payments for services and goods delivered
- provide financial and administrative advice of procurement and grant matters, as needed
- provide financial analysis and financial management support to the operational unit
- monitor budget execution and report to the Executive Director
- update budget forecast for the period up to 2017 and report to the Governing Board
- monitor changes in the Financial Regulations and related rules and implement where required
- develop or update procedures and streamline workflows as necessary in coordination with the Programme Unit
- coordinate and support missions of the Court of Auditors

Achievement is measured through the following indicators:

- level of budget execution
- payments made on target within deadlines
- quality of the monitoring & reporting on budget execution
- number of exceptions (deviations from rules and procedures) recorded
- number and importance of findings of the IAS and opinion of the Court of Auditors
- feedback from staff

<u>Human Resources and General Administration</u>

The priority objectives for Human Resources are to ensure that the establishment plan and Staff policy plan are implemented, to ensure an efficient management of resource allocation and to ensure an optimal working environment.

Main activities include the following:

- complete the recruitment plan, efficiently replace posts that become vacant
- implement the HR policies and related control standards

- update internal procedures to ensure clear understanding of roles and responsibilities
- monitor adequacy of staff resources in relation to activities
- promote professional development through training
- ensure delivery of logistical support (stationery, procurement of goods and services)
- implement security policy
- facilitate social contact between staff

Achievement is measured through the following indicators:

- vacancy rate
- number and importance of findings of the IAS and opinion of the Court of Auditors
- feedback from staff (staff satisfaction)

Legal

The priority objectives of Legal affairs are to ensure the legality and regularity of grant agreements, contracts and other agreements (memorandum of understanding, service level agreement, amendment to agreements and contracts) and provide guidance and advice to ensure compliance with applicable legislation and rules. It also includes the Data Protection function.

Main activities include the following:

- generate and check grant agreements
- review contracts prior to signature
- provide advice or input on legal issues, on interpretation of texts, on draft legislation or internal rules and procedures
- develop an effective document management system
- set-up the data protection function

Achievement is measured by the following indicators:

- number of amendments in agreements and contracts due to inconsistencies
- number of complaints, legal disputes
- document management tool and related procedure in place
- register of data protection notifications in place
- number and importance of findings of the IAS and opinion of the Court of Auditors

IT

The priority objective for IT are to ensure a stable and secure IT system, provide IT support to staff in the use of IT applications and equipment and to cooperate with the other JUs to ensure synergy and efficient use of resources.

Main activities include the following:

- follow-up and monitor implementation of the contract with IT supplier, notably service delivery plan; ensure maintenance and upgrades are done as necessary
- monitor stability of the IT system
- participate in coordination meetings with the Commission and other JUs and take action follow-up on the adjustments needed to allow and ensure smooth functioning of FP7 IT tools
- implement VPN, WIFI

Achievement is measured by the following indicators:

- compliance by contractors/ service providers with the service level agreements
- level of downtime
- user satisfaction on the tools (equipment and applications)
- number and importance of findings of the IAS and opinion of the Court of Auditors

Accounting

The priority objective of Accounting is to provide management information about the financial position, performance and cash flows of FCH JU that is compliant with FCH JU Financial regulation and Commission accounting rules and methods; that is useful to a wide range of users for decision making and that shall demonstrate the accountability of the entity for the resources entrusted to it.

Main activities include the following:

- payment execution and treasury management
- collection of receipts and recovery of established entitlements
- keeping the accounts and implementing the accounting rules and methods and the chart of accounts in accordance with the provisions adopted by the Commission's accounting officer
- preparation and follow up of provisional annual accounts and annual accounts:
- validation of the accounting system
- liaise with and assist the Court of Auditors

Achievement is measured by the following indicators:

- timely preparation of annual accounts
- number and importance of observations of the Court of Auditors related to the reliability of accounts

Internal Audit

The priority objectives of Internal Audit are to provide the Executive Director with assurance (i.e. independent assessment) and consulting (i.e. advisory and management requested) services as to the effectiveness and efficiency of the governance, risk management and control processes in the Joint Undertaking.

Main activities include the following:

- establish a multiannual work plan (to be updated annually), including assurance and consulting services, in coordination with the Commission's Internal Audit Service (IAS)
- implement the annual work plan
- maintain a smooth, constructive and transparent liaison with the audit community (i.e. Auditnet, IAS and Court of Auditors)
- upon the Executive Director's request, provide other ad-hoc consultancy or assurance services not foreseen in the annual work plan
- ensure an advisory role in the Annual Activity Report (AAR) process, internal control, risk management and ex-post audits of beneficiaries

Achievement is measured by the following indicators:

- performance against annual work plan
- participation to Auditnet meetings
- coordination level with the IAS (joint risk assessment and coordinated multiannual work plan)
- feedback from Executive Director

5. Resources

The staff and financial resources of the FCH for the year 2011 were adopted by the European Parliament and the Council in accordance with the budgetary procedure and are described in the following sections.

5.1 Staff establishment plan 2011

Temporary Agents

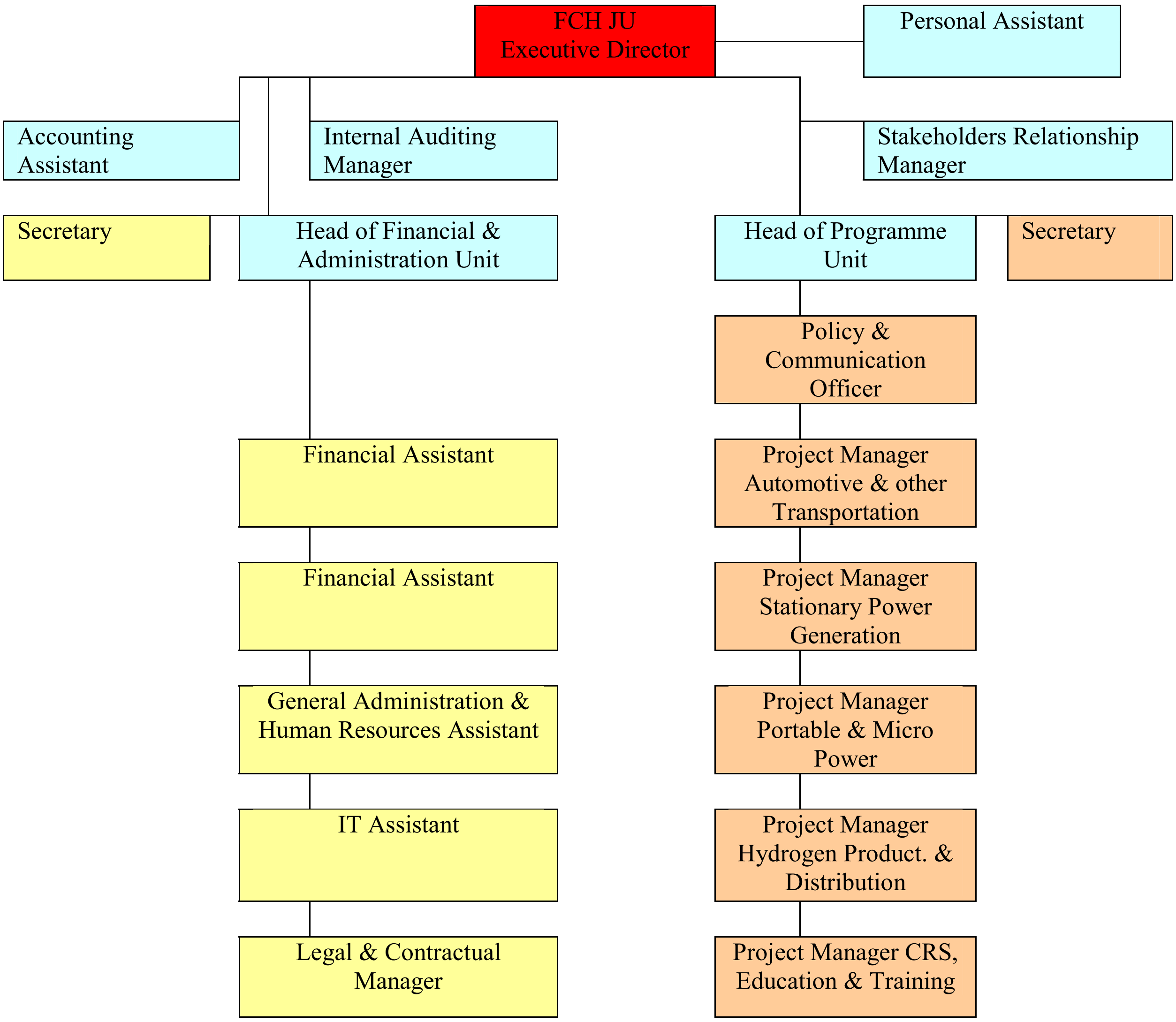
Grade	2011 Establishment Plan	
	Budget / Authorised	
	Permanent posts	Temporary posts
AD 16		
AD 15		
AD 14		1
AD 13		
AD 12		
AD 11		3
AD 10		
AD 9		1
AD 8		4
AD 7		2
AD 6		
AD 5		
Total *AD*[34]	**0**	**11**
AST 11		
AST 10		
AST 9		
AST 8		1
AST 7		3
AST 6		
AST 5		

[34] AD stands for Administrator

AST 4		1
AST 3		2
AST 2		
AST 1		
Total *AST*[35]	**0**	**7**
TOTAL	**0**	**18**

Staff resources also include 2 contract agents, 1 in Function Group (FG) III and 1 in FG IV. The allocation of staff is shown in the organisation chart here below:

FCH JU ORGANISATIONAL STRUCTURE –



[35] AST stands for Assistant

5.2 FCH BUDGET 2011

5.2.1 Statement of Revenue (payment appropriations)

Title Chapter Article Item	Heading	Budget[36] in EUR
2001	***European Commission subsidy for operational expenditure***	56,209,324
2002	***European Commission subsidy for administrative expenditure***	1,073,889
2003	***Industry Grouping contribution for administrative expenditure***	2,570,667
2004	***Research Grouping contribution for administrative expenditure***	428,444
2006	***JTI revenues***	p.m.
	CHAPTER 2 0 — TOTAL	60,282,324
	Title 2 — Total	**60,282,324**
	GRAND TOTAL	**60,282,324**

[36] Carry-over of payment appropriations 2010 (4 127 814,59€) is not included

5.2.2 Statement of expenditure

Title Chapter Article Item	Heading	Commitment Appropriations 2011- in EUR	Payment Appropriations 2011[37]- in EUR
1	**STAFF EXPENDITURE**		
1 1	STAFF IN ACTIVE EMPLOYMENT	2,091,000	2,091,000
1 2	EXPENDITURE RELATED TO RECRUITMENT	101,000	101,000
1 3	MISSIONS AND TRAVEL	100,000	100,000
1 4	SOCIOMEDICAL INFRASTRUCTURE	78,000	78,000
1 7	ENTERTAINMENT AND REPRESENTATION EXPENSES	20,000	20,000
	Title 1 - TOTAL	**2,390,000**	**2,390,000**
2	**INFRASTRUCTURE**		
2 0	INVESTMENTS IN IMMOVABLE PROPERTY RENTAL OF BUILDINGS AND ASSOCIATED COST	373,200	373,200
2 1	INFORMATION TECHNOLOGY	101,500	101,500
2 2	MOVABLE PROPERTY AND ASSOCIATED COSTS	22,000	22,000
2 3	CURRENT ADMINISTRATIVE EXPENDITURE	68,000	68,000
2 4	POSTAGE AND TELECOMMUNICATIONS	28,300	28,300
2 5	EXPENDITURE ON FORMAL AND OTHER MEETINGS	40,000	40,000
2 6	RUNNING COSTS IN CONNECTION WITH OPERATIONAL ACTIVITIES OF FCH	601,000	601,000
2 7	STUDIES	5,000	5,000
2 8	EXPERT CONTRACTS AND MEETINGS	444,000	444,000

[37] Carry-over of payment appropriations 2010 (4 127 814,59€) is not included

	Title 2 — Total	**1,683,000**	**1,683,000**
3	**OPERATIONAL EXPENDITURE**		
3 0	IMPLEMENTING THE RESEARCH AGENDA OF FCH JU	113,145,257	56,209,324
	Title 3 - TOTAL	113,145,257	56,209,324
	GRAND TOTAL	**117,218,257**	**60,282,324**

6. Annexes

6.1 Abbreviations and Definitions

Term	Definition
AA	Application areas such as Transportation & Infrastructure, Hydrogen Production & Distribution etc.
AA1 / AA-T	Application Area Transportation & Refuelling Infrastructure
AA2 / AA-H	Application Area Hydrogen Production, Storage & Distribution
AA3 / AA-S	Application Area Stationary Power Generation & CHP
AA4 / AA-EM	Application Area Early Markets, short-term markets encompassing a group of applications for which products can be commercially deployed within the 2007-2013 timeframe
AC	Associated Country means a third country which is party to an international agreement with the Community, under the terms or on the basis of which it makes a financial contribution to all or part of the Seventh Framework Programme
AIP	Annual Implementation Plan
APU	Auxiliary Power Unit
AST	Accelerated Stress Test
BoL	Beginning-of-Life
BOP	Balance of Plant
BPP	Bipolar Plates
BTH	Biomass to Hydrogen
BUP	Back-Up Power
CAES	Compressed Air Energy Storage
CAPEX	Capital Expenditures
CCI	Cross Cutting Issues
CCS	Carbon Capture and Sequestration
CFD	Computational Fluid Dynamics
CHP	Combined Heat and Power

CP	Collaborative Project
CSA	Coordination and Support Action
EC	European Commission
Deployment	Development phase for a given technology and/or infrastructure from its market introduction to its widespread use
DME	Dimethyl Ether
DSM	Demand Side Management
ED	Executive Director
EFTA	European Free Trade Area
EMC	Electromagnetic Compatibility
EoL	End-of-Life
ETP	European Technology Platform
FCH	Fuel Cells & Hydrogen
FCH JU	The Fuel Cells and Hydrogen Joint Undertaking: the name refers to the legal entity established as the public & private partnership to implement the Joint Technology Initiative
FCEV	Fuel Cell Electric Vehicle
FP7	Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007-2013)
GB	Governing Board of the FCH JU
GDL	Gas Diffusion Layer
HFP	The European Hydrogen and Fuel Cell Technology Platform
HTE	High Temperature Electrolysis
IDA	Innovation and Development Actions: A programmatic cluster of the HFP Implementation Plan targeting a specific objective of the programme and encompassing a set of relevant technologies and market enablers along with the actions to achieve it
IG	New Energy World Industry Grouping - European Industry Grouping for a Fuel Cell and Hydrogen JTI also referred to as "Industry Grouping" or "NEW IG"
ILCD	International Reference Life Cycle Data System
IP	Implementation Plan

ISO	International Organization for Standardization
JTI	Joint Technology Initiative - a policy initiative introduced in the FP7. The Term JTI may also be used to refer to the legally established structure implementing the initiative (cf. above FCH JU)
LCA	Life Cycle Assessment
LHV	Lower Heating Value
MAIP	Multi-Annual Implementation Plan
MCFC	Molten Carbonate Fuel Cells
MEA	Membrane- Electrode Assembly
MHE	Material Handling Equipment
Members	The term "members" refers to the founding members of the FCH JU (EC & NEW IG) and the RG
MPL	Micorporous Layer
MS	The "Member States" shall be understood as the EU-27 Members States
NEDC	New European Driving Cycle
OEM	Original Equipment Manufacturer
OPEX	Operational Expenditures
PEM / PEMFC	Proton Exchange Membrane Fuel Cell
PNR	Pre-normative research
PO	Programme Office (also referred to as JTI PO)
PoC	Proof of Concept
RAT	Ram air turbine
RCS	Regulations & Codes and Standards
RES	Renewable Energy Sources
RG	New European Research Grouping on Fuel Cells and Hydrogen AISBL, also referred to as " Research Grouping" or "N.ERGHY"
RH	Relative Humidity
RTD	Research, Technological Development & Demonstration
SAE	Society of Automotive Engineers
SME	Small and Medium Enterprise

SOFC	Solid Oxide Fuel Cell
SRG	FCH States Representatives Group: Advisory body of the FCH JU gathering Member States and Associated Countries' representatives
Stakeholders	The term "Stakeholders" embodies all public or private actors with interests in FCH activities both from the MS or third countries. It shall not be understood as "partners" or "members" of the FCH JU.
TCO	Total Cost of Ownership
UPS	Uninterruptible Power Supply
WtT	Well to Tank
WtW	Well to Wheel