ANNUAL ACTIVITY REPORT 2018

FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

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FCH JOINT UNDERTAKING

Publicly available

ANNUAL ACTIVITY REPORT 2018

In accordance with Article 17 of the Statutes of the FCH 2 JU annexed to Council Regulation (EU) No 559/2014 and with Article 20 of the Financial Rules of the FCH 2 JU.

The annual activity report will be made publicly available following its approval by the Governing Board.

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FACTSHEET

NAME	Fuel Cells and Hydrogen 2 Joint Undertaking
OBJECTIVES	a) To contribute to the implementation of Regulation (EU) No. 1291/2013, and in particular the Secure, Clean and Efficient Energy Challenge and the Smart, Green and Integrated Transport Challenge under part III of I of Decision 2013/743/EU (b) To contribute to the objectives of the Joint Technology Initiative on Fuel Cells and Hydrogen, through the development of a strong, sustainable and globally competitive FCH sector in the Union
FOUNDING LEGAL ACT	Council Regulation (EU) No. 559/2014 of 6 May 2014 – OJ L169/108-129 of 7.6.2014
EXECUTIVE DIRECTOR	Bart Biebuyck
GOVERNING BOARD	Chair: Valérie Bouillon-Delporte Vice-Chair: Patrick Child Governing Board composition: http://www.fch.europa.eu/page/governing-board
OTHER BODIES	States Representative Group, Scientific Committee, Stakeholder Forum
STAFF	25 temporary agents and 2 contract agents
2018 BUDGET	EUR 85.5 million of which EUR 79.8 million allocated to operational activities and EUR 5.7 million to administrative expenses
BUDGET IMPLEMENTATION	93 % in terms of commitment appropriations 83 % in terms of payment appropriations
GRANTS	90 signed for a total value of EUR 448.9 million
STRATEGIC RESEARCH AGENDA	Addendum to the Multi-Annual Work Plan 2014-2021 was endorsed by the Governing Board on 15 June 2018
CALL IMPLEMENTATION	Number of calls launched in 2018: 1 Number of proposals submitted: 61 Number of eligible proposals: 58 Number of proposals funded: 17 Global project portfolio (since setting up): 155 projects under FP7 and 90 signed projects under H2020 Number and value of tenders: 5 studies were contracted in 2018 for a total value of EUR 2.2 million
PARTICIPATION, INCLUDING SMES	Total number of participations in funded projects: 894 of which: % of SMEs: 26 % of private for profit/large companies: 36

FOREWORD

During 2018, fuel cells and hydrogen (FCH) technology attracted strong interest from policymakers and citizens as one of the important technologies able to help to decarbonise our society and economy. The FCH 2 JU contributed to that significantly by a wider dissemination of project results and outreach. A special focus last year was on the Central and Eastern European countries. In May, a Central and Eastern European tour was organised with a Hydrogen Summit in Sofia, Bulgaria involving citizens in a family day and policymakers. The FCH 2 JU was present at the EC booth during the TEN-T days in Ljubljana, Slovenia where it displayed a hydrogen car and bus. In the framework of the cities and regions initiative, a number of workshops took place in Central and Eastern Europe. During all these events, a clear interest was observed in moves to start investing in FCH technologies.

Thanks to the many FCH 2 JU research projects on green hydrogen production, the CAPEX costs for electrolysers has been drastically reduced while the capacity has been increased from kilowatt (kW) to megawatt (MW) scale. This has attracted the interest from large industries like steel or refineries which are starting to implement this technology in order to decarbonise their sites. During the EU Austrian Presidency, an informal energy ministerial took place at the site of one of our projects 'H2FUTURE', where industry and 25 European energy ministers signed the 'Hydrogen Initiative'. The next big step is to move to gigawatt (GW) scale and therefore, since May 2018, with the support of the FCH 2 JU, the European Commission (EC) has been co-leading a new Mission Innovation and Challenge on hydrogen.

Regulations will be crucial for the fast uptake of FCH technology. The FCH 2 JU is contributing via pre-normative research projects, testing a 'guarantee of origin' scheme through the Certifhy project or by providing feedback on project results for policymakers. In our maritime projects, in particular, we see the urgent need to develop regulations. So, together with the EC, those findings were presented to the International Maritime Organization (IMO) and discussed in various workshops.

The FCH 2 JU is fulfilling its objective to bring hydrogen and fuel cell products to the point of market readiness by 2020. Various products, be it in transport or energy, are being demonstrated in the field where European citizens can experience them (e.g. buses or micro-combined heat and power (m-CHP)). Preliminary results from our studies, such as the value chain and the hydrogen roadmap for Europe, show that this technology has huge potential to create many high-value jobs and significant growth in Europe. To realise this, it will be key to work on three main pillars: first, to go back to basic research to further reduce the costs and prepare next-generation products; secondly, to scale-up the current generation of products; and finally, to prepare the whole supplier chain.

In 2018, the FCH 2 JU programme budget execution, leverage effects and error rates were excellent, and all the previous IAS recommendations were implemented. This success was achieved thanks to the hard work and dedication of many people determined to make a greener and healthier world using FCH technology: colleagues in the European Commission, members of the Governing Board (GB), the States Representative Group, the Scientific Committee and the many stakeholders who have given us their valuable inputs on our plans and activities.

Finally, I would like to thank my excellent and professional team in the programme office, who do their best every day to serve the interests of European citizens. The 2018 SME Hero Award for the FCH 2 JU from SME Europe is a clear recognition in that sense.

Enjoy the read

Bart BIEBUYCK
FCH 2 JU Executive Director

EXECUTIVE SUMMARY

2018 was another successful year for the FCH 2 JU. It was marked by further progress in achievements, results and initiatives, major events, enhanced outreach activities including, for the first time, the FCH awards and a publicity campaign, promising results from studies, and confirmation of the significant leverage, excellent budget execution, low error rate, update of the FCH 2 JU GB strategic priorities, and ambitious plans for the future.

Further progress in demonstration and research results is described in this report and in more detail in the 2018 Programme Review Report[1].

Highlights worth mentioning include:

- FCH 2 JU's support for demonstration activities in the transport sector concern **over 1 900 light vehicles** in 14 countries of which **more than 630 are already in operation**, **355 buses**, with 45 currently in operation in 10 cities and a technology which is now close to commercial reality (at TRL 8), and a **network of 99 hydrogen refuelling stations (HRS)** in 14 countries of which 48 are already in operation. **The European FCH bus deployment can be considered as worldwide state-of-art** and has progressed considerably throughout the projects. The success of these bus demonstration projects has also been proven by the fact that in different cities, bus operators have joined the projects even after they have started. This also shows the **growing involvement of regions** and a steady increase in the contributions from other sources (private, national, regional, etc.) to finance the demonstration projects.

- **Research-oriented activities for transport applications** have enabled considerable progress in the production of state-of-the-art stacks for automotive application, with development activities going through scale-up and successful automotive cell and stack testing.

- Thanks to the support of the FCH 2 JU programme, it has been possible to scale up the capacity of **electrolysis technology** over the years, moving from the kW level to the multi MW while inversely reducing the share of FCH 2 JU support and fostering synergies across EU, regional, national and private funds. As an example, the REFHYNE project will install 10 MW in a German refinery. Proton exchange membrane (PEM) electrolysers have **already reached the 2020 Multi-Annual Work Plan (MAWP) target regarding energy consumption, a very small footprint and a reduction in the use of platinum group metals (PGM)**.

- In stationary fuel cell applications, fuel cells have shown great potential, in particular for residential mCHP due to their high total and electrical efficiencies, and their ability to run on conventional heating fuels. Technology leaders in this sector are approaching wide commercialisation following extensive field trials of approximately 3 800 units of installed m-CHP FC systems. The FCH-funded project ENE.FIELD[2] and its successor, PACE[3], represent **Europe's largest deployment of FC mCHP to date**, and have allowed manufacturers to reduce costs considerably and build alternative heating markets.

- **Pre-normative research activities have led to considerable progress** in defining credible potential cost reductions, reviewing hydrogen impurity mapping, and developing improved analytical methods. This has also enabled the development of EU laboratories[4] for the required analysis **and successful engagement with standardisation bodies**.

- As regards the removal of legal barriers, for the first time, project HyLAW has performed a **complete analysis of the legal rules applicable to the deployment of FCH technologies at Member-State level**, mapping the so-called legal framework and administrative processes (LAPs). An interactive online database allows for a public, detailed and well-structured assessment of the findings.

A number of initiatives delivered valuable results, among which the following are underlined:

- Launched in 2017, the European Hydrogen Safety Panel (EHSP) came into operation. Notably, it produced a safety guidance document[5] for FCH projects and programmes in Europe. This first-of-its-kind guidance document aims to assist Europe in identifying minimum safety requirements, hazards and associated risks and in generating a quality safety plan that will serve as a helpful guide for the inherently safer conduct of all work related to the development and operation of FCH systems and infrastructure in Europe.

1 The report will be published in spring 2019 on the FCH 2 JU website: https://fch.europa.eu/page/programme-review-days-2018

2 http://enefield.eu/

3 http://www.pace-energy.eu

4 As part of Hydraite project: https://hydraite.eu/

5 The document will be publicly available on the EHSP webpage.

- The **Regions Initiative**, which was launched in 2016 and to date has gathered **91 regions and cities from 22 countries and more than 55 industry partners**, was pursued in 2018 via the **organisation of local workshops** to promote the exchange of knowledge on best practices in FCH project development and discussions on the best way for European cities and regions to implement such projects. The final report[6] was made public. To capitalise on this work, a number of actions have been agreed including, notably, a topic in call 2019 to develop hydrogen valleys, while discussions have been initiated with the Joint Research Centre (JRC) in view of the creation of a new Hydrogen and Fuel Cells Energy Partnership under the Smart Specialisation Platform[7].

During the year, major events and other outreach activities took place including, among others:

- The **Hydrogen Summit** was organised in Sofia, Bulgaria on 28 May 2018 by the FCH 2 JU **during the Bulgarian Presidency of the Council of the EU** and marked the 10th anniversary of the Joint Undertaking. It was attended by a number of Bulgarian politicians, including MEP Peter Kouroumbashev, Minister of Education Krasimir Valchev, and Deputy Transport Minister Anguel Popov, who said that hydrogen-fuelled vehicles represented the future of cars.

- The Summit was part of a Central and Easter European (CEE) tour with additional events in Budapest (Hungary) and Timişoara (Romania). Supported by local hydrogen associations and policymakers, these events sparked a lot of interest among both the participants and the general public. The FCH 2 JU's two hydrogen fuel cell cars were on display and available to test drive. In Budapest, István Lepsényi, state secretary from the Ministry for National Economy and László Palkovics, state secretary from the Ministry of Human Capacities met with Bart Biebuyck to discuss the current situation and future plans for FCH technologies in Hungary.

- The mayor's office in Timişoara welcomed the event. Representatives of the FCH 2 JU were pleased to meet Mayor Nicolae Robu and introduce the Joint Undertaking's work. Two Members of the European Parliament took the opportunity to test drive the fuel-cell cars, gaining a new appreciation of the many advantages of FC technologies.

- Another key event in 2018 was the presentation of the H2FUTURE project in the context of the informal meeting of EU energy ministers on 17 and 18 September in Linz, Austria, when the Austrian Presidency of the Council of the European Union launched the **Hydrogen Initiative**[8]. Under this initiative, the signatory States commit to continuing research and investment in the production and use of hydrogen as a future oriented technology. 'Green hydrogen offers significant potential for the decarbonisation of the European economy. The Commission warmly welcomes the Hydrogen Initiative as it will further harness the innovative drive across the EU,' said Miguel Arias Cañete, EU Commissioner for Climate Action and Energy.
  To date, 26 Member States, two European Free Trade Association (EFTA) States, the European Commission and around 100 businesses, organisations and institutions have supported the Hydrogen Initiative.

6 https://www.fch.europa.eu/sites/default/files/181123_FCHJU_Regions_Cities_Final_Report_FINAL.pdf

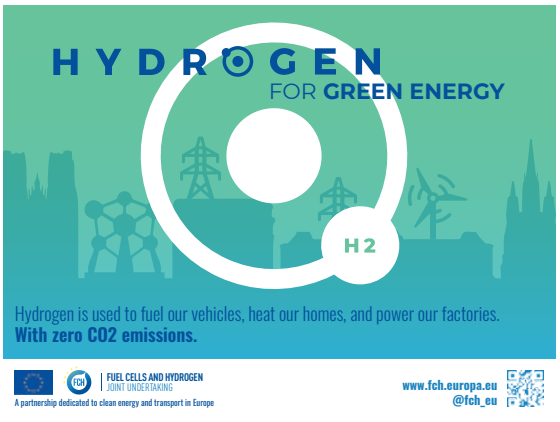
7 http://s3platform.jrc.ec.europa.eu/home

8 https://www.eu2018.at/latest-news/news/09-18-Informal-meeting-of-energy-ministers.html

The **H2FUTURE project** aims to build one of **Europe's largest electrolysis plants for the production of green hydrogen** and it is an important milestone on the path towards **coupling the energy and industry sectors**.

- The 2018 Stakeholder Forum (SF) was a success, gathering 400 participants: discussions focused on using hydrogen for the integration of renewables, sector coupling, and on the potential of hydrogen in the global context of decarbonising the economy. 'Hydrogen is a key technology for achieving Europe's climate and energy goals. Its potential benefits for the environment, consumers and European economy can power the transition of Europe's energy sector towards a green future,' said Maroš Šefčovič, Vice-President of the European Commission for Energy Union, speaking at the SF. For the first time, the FCH 2 JU organised an **Awards Ceremony** to reward its top projects for innovation excellence. The winners were chosen by public vote, which mobilised the European FCH community around the 26 nominees – 13 for each of the 2 categories (success stories and innovation).

- A pilot awareness campaign was carried out in Brussels. It included posters and banners, alongside a promotional video, displayed in the city subway and public transport network. It also featured a social media component. Through the campaign, the FCH reached out to a wider public, beyond the hydrogen (H2) industry and research community, with simple messages focusing on H2 applications (H2 for green energy and H2 for green transport) and on the Joint Undertaking (a partnership dedicated to clean energy and transport in Europe). Statistics on the campaign showed it had a good impact, as evidenced by an increase in the traffic on the FCH 2 JU website.



- In April 2018, the FCH 2 JU was present at the **Hannover Messe**, one of the world's largest trade fairs which also provides the arena for Europe's largest hydrogen, fuel cells and battery exhibition. Numerous FCH 2 JU beneficiaries attended the fair as exhibitors and speakers in the public and technical forums during the week. The FCH 2 JU participated with a **dedicated slot entitled 'FCH 2 JU supporting European SMEs, accelerating technological breakthroughs'**. Three small and medium-sized enterprises (SME) beneficiaries of FCH 2 JU funding – Elcogen, HyET and Hydrogenious – discussed the topic alongside the Joint Undertaking's Executive Director Bart Biebuyck who emphasised that SMEs are the backbone of the FCH sector in Europe, thanks to their invaluable ability to innovate and adapt quickly. **SMEs represent 25 % of participants and more than 30 % of the FCH 2 JU funding in FCH projects**, exceeding the Horizon 2020 target of 20 %.

- FCH 2 JU was awarded the **SME Star Hero Award** by SME Europe[9] at a ceremony in the European Parliament on 17 October 2018. This Award is 'dedicated to Individuals, projects or institutions that greatly contributed to the SME policies whether in their region or on a global scale'.

- Four studies were launched, contracted through open procurement procedures, on the concept of an HRS availability system, establishing an FCH market and policy observatory, the use of FCH technologies in the railway sector, and developing a hydrogen roadmap for Europe. The first two are expected to deliver useful tools and monitoring systems while the last two demonstrate the potential of FCH technologies in other sectors and the key role of hydrogen in energy transition (see below).

- **Significant leverage** – with certified and reported results on additional activities for 2018, together with certified and committed contributions in projects from all private partners from Calls 2014-2018, for the first time, the overall confirmed investment for 2014-2018 from private partners has exceeded EUR 1 billion.

- The leverage effect from members only reached EUR 1.36 (compared to the requirement of 0.57). In other words, for every euro of EU contribution for all signed H2020 FCH 2 JU grant agreements, as at 31 December 2018, members of Hydrogen Europe Industry and Hydrogen Europe Research committed to spend EUR 1.36 either on FCH 2 JU projects or on additional activities. Furthermore, taking into account in-kind contributions in projects from all private partners, the leverage reached EUR 1.96.

- **Budget execution** remained **excellent** with 93 % in terms of commitment appropriations and 83 % in terms of payment appropriations.

- In 2018, the ***ex-post* audit results for the Seventh Framework Programme (FP7) confirmed** stable and even declining trends in the **residual error rates to below 2 %** towards the end of the programme. At the same time, 2018 was the first year when validated H2020 expenditure was slightly higher than that of FP7. Even though still early in the programme, **H2020 *ex-post* audit** results specific for FCH 2 JU **gave a promising result of a residual error rate below 0.5 %**.

- As of 31 December 2018, FCH 2 JU successfully implemented all the action plans and recommendations stemming from previous annual internal audits conducted by the Internal Audit Service (IAS). In January 2019, in its letter to the FCH 2 JU Governing Board (GB), the IAS confirmed that there are no open recommendations and action plans. This demonstrates that internal control of the FCH 2 JU is mature, sound and strong. Similarly, the recommendations included in the action plan on interim evaluation adopted by the FCH 2 JU GB in March 2018 and within the remit of the Joint Undertaking were implemented.

- The smooth administrative functioning of the FCH 2 JU was further enhanced with the adoption of the document management system ARES (Advanced Records System) and the development of new paperless workflows.

- The FCH 2 JU GB updated the strategic priorities for the years 2019 and 2020. Furthermore, in February 2018, in the context of preparations for the next EU Framework Programme and the proposal for Horizon Europe[10] adopted by the European Commission on 7 June 2018, the FCH 2 JU private members released their strategic plan 2020-2030[11] 'Hydrogen, enabling a zero emission Europe', laying out their vision and ambition for the future of the sector. The study commissioned by the FCH 2 JU, 'Hydrogen Roadmap Europe: A sustainable pathway for the European Energy Transition'[12], confirms that hydrogen is an essential element in the energy transition and that it can account for 24 % of final energy demand and 5.4 million jobs by 2050.

9 http://www.smeeurope.eu/about-us/

10 https://ec.europa.eu/info/designing-next-research-and-innovation-framework-programme/what-shapes-next-framework-programme_en

11 https://www.hydrogeneurope.eu/sites/default/files/2018-10/Public_HE%20Tech%20Roadmaps_full%20pack_0.pdf

12 https://fch.europa.eu/news/hydrogen-roadmap-europe-sustainable-pathway-european-energy-transition

INTRODUCTION

Council Regulation No. 559/2014 set up the current Fuel Cells and Hydrogen Joint Undertaking (FCH 2 JU) under the Horizon 2020 Framework Programme as a unique institutionalised public-private partnership (IPPP) supporting research, technological development and demonstration (RTD) activities in FCH technologies in Europe, aiming to accelerate their commercialisation by 2020. This demonstrates the EU's continued confidence and support for FC and hydrogen (FCH) as key technologies (fuel cells as an energy-efficient converter and hydrogen as a clean energy carrier) for decarbonising Europe's energy system and creating a secure sustainable energy supply capable of generating new jobs.

At the Paris climate conference (COP 21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. The agreement sets out a global action plan to avoid dangerous climate change, by limiting global warming to 2 °C '... and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius'. The EU has always been at the forefront of international efforts towards a global climate deal and was therefore the first major economy to submit its intended contribution to the new agreement in March 2015.

Underpinning this, the EU has committed to build an Energy Union to ensure Europe's energy supply is safe, viable and accessible to all, which can boost the economy and attract investments, and create new job opportunities. The EC in its Communication[13] on 'A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy' developed a strategy based on the following five dimensions:

1. Security, solidarity and trust;
2. A fully integrated internal energy market;
3. Energy efficiency;
4. Climate action – decarbonising the economy;
5. Research, innovation and competitiveness.

This requires wiser energy use and effective measures to fight climate change. Every year, the 'State of the Energy Union reports should show progress made on the transition to a low-carbon, secure and competitive EU economy.

As an immediate action, in November 2016, the EC adopted the 'Clean energy for all Europeans' package[14] which includes revised legislative proposals covering energy efficiency, energy performance in buildings, renewable energy, the design of the electricity market, security of electricity supply and governance rules for the Energy Union. After several years of political discussions, on 14 June 2018, the Commission, the Parliament and the Council reached a political agreement[15] which includes a binding renewable energy target for the EU for 2030 of 32 %, with a clause for an upwards revision by 2023. The role of renewable gas, including green hydrogen, is explicitly mentioned which would open the door for green hydrogen to contribute to Member States' renewable energy and transport targets. During the same political agreement, a more ambitious energy efficiency target of 32.5 % for the EU for 2030 was set, with an upwards revision clause by 2023.

In its 'Second Report on the State of the Energy Union' from February 2017[16], the European Commission published a Staff Working Document (SWD) on energy storage which outlines, clearly for the first time, the role of energy storage in relation to electricity, presents the advantages of different technologies and innovative solutions in different contexts, and discusses further possible policy approaches. Whilst acknowledging that energy storage, including hydrogen-storage-based solutions, has yet to develop its full potential in the energy markets, developing affordable and integrated energy-storage solutions is highlighted as a priority to facilitate and enable the transition to a low-carbon energy system based largely on renewables. In order to progress on this, a High Level Roundtable on Energy Storage and Sectoral Integration[17] was organised by the EC on 1 March 2018 and brought together representatives from industry, research and the Commission to discuss the role energy storage and sectoral integration can play in the transition to a low-carbon economy. Sectoral integration is the linking of energy (electricity, gas and heat),

13 COM(2015)80, Energy Union Package.

14 Clean energy for all Europeans package: https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

15 http://europa.eu/rapid/press-release_STATEMENT-18-4155_en.htm

16 https://ec.europa.eu/energy/sites/ener/files/documents/swd2017_61_document_travail_service_part1_v6.pdf

17 https://ec.europa.eu/info/events/high-level-roundtable-energy-storage-and-sectoral-integration-2018-mar-01_en

transport and industrial infrastructure with the aim of boosting use of energy from renewable sources and decarbonising the economy. Together with energy storage, it has the potential to make the clean energy transition – which needs to cover all sectors of the economy – faster and more cost-effective.

It became clearer during 2018 that the development of *hydrogen storage solutions will serve the strategic purpose of strengthening links between the energy and the transport sectors* and facilitate the transition of the EU toward a low-carbon society. As highlighted in the EC SWD 'Towards clean, competitive and connected mobility: the contribution of Transport Research and Innovation to the Mobility package', the expected increase in renewable hydrogen production will help the EU to address its decarbonisation and quality of air challenges linked to the transport system. As part of the same package, an action plan and investment solutions for the trans-European deployment of Alternative Fuels Infrastructure[18] was proposed, which includes hydrogen as one of the clean fuels for transport. The aim is to increase the level of ambition of national plans, to increase investment and improve consumer acceptance.

In addition, a proposal was made to amend the Clean Vehicles Directive to promote clean mobility solutions in public procurement tenders and thereby provide a solid boost to the demand for and further deployment of clean mobility solutions, including FC vehicles. On 17 May 2018, the EC presented a new mobility package entitled 'Sustainable Mobility for Europe' with which it seeks to promote safe, connected and clean mobility across the EU. This third and last mobility package[19], from the Juncker Commission, contains various legislative and non-legislative proposals for the EU's automobile industry.

Furthermore, in 2018, there was a global agreement for the first time within the IMO on targets to reduce greenhouse gas (GHG) emissions from maritime transport by a minimum of 50 % by 2050 and to phase it out completely before the end of the century. This represents a substantial challenge, while the possibility of using fuel cells, together with hydrogen or other zero-carbon fuels, as a very promising energy source for large-scale shipping is increasingly being considered.

On 18 September 2018, the use of hydrogen as a future-oriented energy form was among the items on the agenda of the informal meeting of EU energy ministers[20]. *'The Austrian Presidency of the Council of the European Union proposed a Hydrogen Initiative that many Member States approved of and signed,' said Elisabeth Köstinger, who chaired the EU energy ministers' meeting. 'Under this initiative, the signatory states commit themselves to continue research and investment in the production and use of hydrogen as a future-oriented technology,'* she added. In Linz, where the informal meeting of energy ministers took place on 17 and 18 September, one of the most modern European hydrogen production plants is currently being built (see FCH 2 JU project 'H2FUTURE'[21]).

Similarly, at the international level, the Ministry of Economy, Trade and Industry (METI) and the New Energy and Industrial Technology Development Organization (NEDO) jointly held the First Hydrogen Energy Ministerial Meeting in Tokyo on 23 October 2018[22]. This was the first international ministerial-level meeting to hold discussions (with over 300 stakeholders, including ministerial officials, top executives from related companies and representatives from 21 countries, regions and organisations from around the world) on realisation of the hydrogen-powered society as its main subject. As an outcome of the meeting, the Tokyo Statement will serve as basis for discussions under forthcoming G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth (to be held in June 2019, chaired by Japan) on the importance of the role played by hydrogen in achieving energy transition and decarbonisation.

This has confirmed again at both EU and international level by the commitment of governments to accelerate the development of technologies needed for a global hydrogen market, as initiated in May 2018 (Malmö, Sweden) with the new Hydrogen Innovation Challenge[23] under the leadership of the EC, Germany and Australia.

On 28 November 2018, the EC called for a 'climate neutral Europe by 2050', adopting a 'Strategic long-term vision for a prosperous, modern, competitive and climate neutral economy by 2050 – A Clean Planet for all'[24]. The strategy shows how Europe can lead the way to climate neutrality by investing in realistic technological solutions, empowering citizens, and aligning action in key areas such as industrial policy, finance or research – while ensuring social fairness for a just transition. In the same strategy, which is intended 'not to set targets, but to create a vision and sense of direction', the EC has committed to work closely at the international level with its international partners so that

18 https://ec.europa.eu/transport/themes/urban/cpt_en

19 https://ec.europa.eu/transport/modes/road/news/2018-05-17-europe-on-the-move-3_en

20 https://www.eu2018.at/latest-news/news/09-18-Informal-meeting-of-energy-ministers.html

21 https://www.fch.europa.eu/project/hydrogen-meeting-future-needs-low-carbon-manufacturing-value-chains

22 http://www.meti.go.jp/english/press/2018/1023_007.html

23 http://mission-innovation.net/our-work/innovation-challenges/hydrogen-challenge/

24 http://europa.eu/rapid/press-release_IP-18-6543_en.htm

all parties to the Paris Agreement develop and submit a long-term mid-century strategy in the light of the recent Intergovernmental Panel on Climate Change (IPCC) special report on 1.5 ° C[25].

Finally, on 19 December 2018, the EC welcomed the final political agreement on the conclusion of the Clean Energy for All Europeans package[26] – already launched with sufficient ambition in 2016 – which concludes the political negotiations and represents a major step towards completing the Energy Union and combating climate change, delivering on the priorities of the Juncker Commission. This agreement includes the revised Renewable Energy Directive[27] which recognises hydrogen as a renewable fuel/gas and foresees the creation of guarantees of origin accordingly.

As regards all the policy developments in 2018, as described above, the FCH 2 JU has addressed them through many actions, research and demonstration activities both in line with the above-mentioned EU-wide objectives but also with all of its objectives as listed in Council Regulation 559/2014 of 6 May 2014. The Annual Activity Report (AAR) highlights the main activities and the achievements of the FCH 2 JU in 2018 in line with the Annual Work Plan (AWP) 2018 adopted by the GB on 14 December 2017.

25 https://www.ipcc.ch/sr15/

26 http://europa.eu/rapid/press-release_IP-18-6870_en.htm

27 https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive

01
IMPLEMENTATION OF THE ANNUAL WORK PLAN 2018

1.1 KEY OBJECTIVES 2018 AND ASSOCIATED RISKS

The overall objective of FCH 2 JU is to implement an optimal research and innovation programme at the EU level to develop a portfolio of clean and efficient solutions that exploit the properties of hydrogen as an energy carrier and FC as energy converters to the point of market readiness. This will lend support to EU policies on sustainable energy and transport, climate change, the environment and industrial competitiveness, as embodied in the Europe 2020 strategy, and job creation, and will also help achieve the EU's overarching goal of smart, sustainable and inclusive growth. The overall direction of the programme is guided by the multi-annual plans: Multi-Annual Implementation Plan (MAIP) for 2008-2014 under FP7 and MAWP for 2014-2020 under Horizon 2020. These plans specify targets for the state of FCH technologies in Europe (covering cost, durability and performance) and specific key performance indicators (KPIs). The progress of the programme and therefore scientific/technological achievements are always assessed through the progress towards achieving these targets and KPIs. As the technology has progressed substantially in recent years and new applications have started to emerge, these KPIs (fixed in 2014) were revised and included in an addendum to the MAWP, endorsed by the FCH 2 JU GB on 15 June 2018. The main objectives and achievements are presented in Section 1.2.

Leverage effect

As per the Council Regulation establishing the FCH 2 JU[28], and in order to ascertain a proper overview of the leverage effect, the following contributions from members other than the EU and their constituent entities or their affiliated entities are considered:

- Contributions to the **administrative costs** of the FCH 2 JU;
- Co-financing required to carry out research and innovation actions supported by the FCH 2 JU (i.e. contributions to indirect actions through co-funding in FCH 2 JU projects, the so-called '**IKOP**');
- Contributions towards additional activities by members other than the EU or their constituent entities or their affiliated entities, as specified in an additional activities plan. These additional activities (so-called '**IKAA**') should represent contributions to the broader Fuel Cells and Hydrogen Joint Technology Initiative and the sector as a whole.

The amounts of these contributions as at 31 December 2018 are detailed in the tables below.

TABLE 1.1.1: FINANCIAL CONTRIBUTIONS OF THE MEMBERS TO FCH 2 JU ADMINISTRATIVE COSTS IN 2014 -2018

CONTRIBUTIONS TO RUNNING COSTS RECEIVED BY 31 DECEMBER 2017 / YEAR	INDUSTRY GROUPING	RESEARCH GROUPING	TOTAL
	CASH IN EUR	CASH IN EUR	CASH IN EUR
2014	259 244	42 203	301 447
2015	412 288	67 116	479 404
2016	401 937	65 432	467 369
2017	48 812	7 946	56 758
2018	2 014 054	327 869	2 341 923
TOTAL 2014-2018	**3 136 335**	**510 566**	**3 646 901**

28 Council Regulation (EU) No. 559/2014 of 6 May 2014 establishing the Fuel Cells and Hydrogen 2 Joint Undertaking.

The lower amount in 2017 stems from reactivation of unused contributions from previous years. The higher amount in 2018 is explained by the fact that until 2017 the administrative costs were also funded by FP7 contributions.

TABLE 1.1.2: IN-KIND CONTRIBUTIONS AND EU CONTRIBUTIONS FOR GRANTS UNDER CALLS 2014-2018

CALL YEAR	NUMBER OF PROJECTS	TOTAL EU CONTRIBUTION (A) IN EUR	COMMITTED IN-KIND CONTRIBUTIONS (IKOP) FROM MEMBERS (B) IN EUR	COMMITTED IN-KIND CONTRIBUTIONS FROM NON-MEMBERS (C) IN EUR	TOTAL COMMITTED PRIVATE CONTRIBUTIONS (D = B + C) IN EUR	TOTAL COMMITTED EU + PRIVATE CONTRIBUTIONS (E = A + D) IN EUR
Call 2014	15	82 110 634	28 555 492	15 405 854	43 961 346	126 071 979
Call 2015	15	109 904 751	68 574 801	54 790 047	123 364 848	233 269 598
Call 2016	19	93 974 248	8 163 541	87 967 280	96 130 821	190 105 069
Call 2017	24	114 318 293	12 668 656	109 703 760	122 372 416	236 690 709
Call 2018	17	48 610 139	3 057 882	2 378 542	5 436 424	54 046 563
TOTAL	**90**	**448 918 063**	**121 020 372**	**270 245 483**	**391 265 855**	**840 183 918**

When comparing total committed private contributions (EUR 391.27 million) to total private and EU contributions (EUR 840.18 million) in **FCH 2 JU projects signed until 31 December 2018, the actual average co-funding rate reaches almost 47 %** (approximately 1:1 parity of private – public investment only in FCH 2 JU projects).

Considering that funding rates in projects follow H2020 rules (i.e. up to 100 % of direct costs in research and inn ovation actions (RIAs) and coordination and support actions (CSAs) and up to 70 % in innovation actions (IAs), these private contributions are significantly higher than was initially foreseen. This is due to the fact that most of the largest demonstration projects have effective funding rates lower than 70 % (of direct costs), being very close to the market.

IKAA:

TABLE 1.1.3: IN-KIND CONTRIBUTIONS IN ADDITIONAL ACTIVITIES FOR THE PERIOD 2014-2018

IKAA IN EUR MILLION	2014/2015	2016	2017	TOTAL
Certified IKAA as at 31 December 2018	217.56	164.65	104.09	486.3
IKAA Preliminary Report 2018				186.63
TOTAL	**217.56**	**164.65**	**104.09**	**672.93**

The leverage effect presented below is based on the three following methods:

- **Formula A** considers financial contributions to administrative costs of the FCH 2 JU, IKOP contributions in signed grant agreements (GA) and certified IKAA of members only (other than the EU) compared to total EU contribution in signed GA.

Leverage effect of contributions from members only on the total EU contribution

(3.65 + 121.02 + 486.3 / 448.92) = 610.97 / 448.92 = 1.36

In other words, for EUR 1 of EU contribution for all FCH 2 JU signed H2020 grant agreements until 31 December 2018, the members of Hydrogen Europe Industry and Hydrogen Europe Research committed to spend EUR 1.36 either on FCH 2 JU projects or on additional activities[29].

29 Only certified amounts of the additional activities for years 2014-2017 are taken into account as the activities for 2018 will be the subject of certification later in 2019.

This leverage effect, which only comes from the members from FCH 2 JU projects for 4.5 years and additional activities for 3.5 years alone, already surpasses the minimal threshold of EUR 380[30] million / EUR 665[31] million = 0.57 by more than twice.

- **Formula B** aligned with the method used in the SWD accompanying the Interim Evaluation of the PPPs[32].

Compared to Formula A, in addition the contributions (IKOP, financial and IKAA) from members other than the EU, this formula includes IKOP from non-members other than the EU.

Leverage effect from all committed private contributions on the total EU contribution

(3.65 + 391.27 + 486.3 / 448.92) = 1,067.85 / 448.92 = 1.96

In other words, for EUR 1 of EU contribution for all FCH 2 JU signed H2020 grant agreements until 31 December 2018, the private partners committed to spend EUR 1.96 either on FCH 2 JU projects or on additional activities.

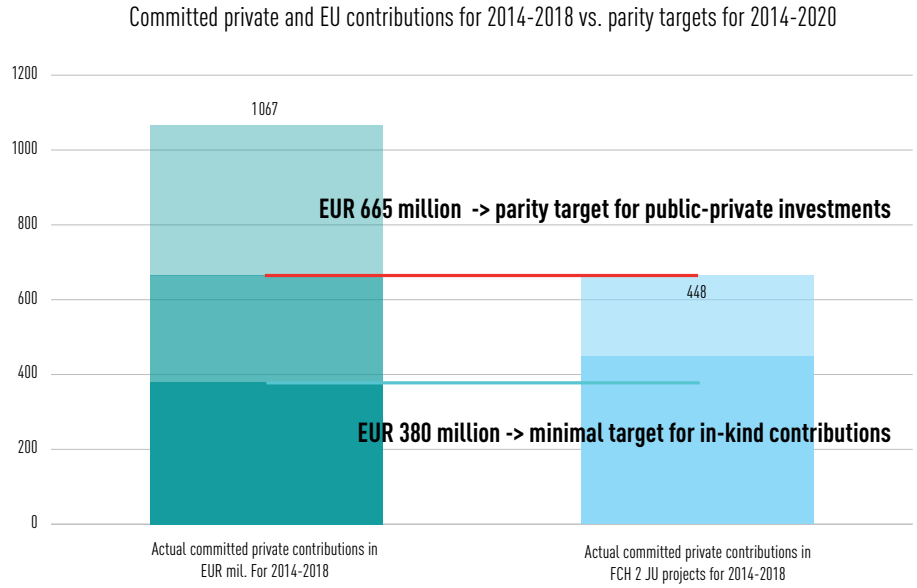
- **Formula C**, in addition to the certified IKAA included in the other two formulas, the reported IKAA for 2018[33] from members other than the EU is also added.

Leverage effect from all committed private contributions on the total EU contribution (in EUR million), including reported additional activities for 2018

(3.65 + 391.27 + 672.93 / 448.92) = 1.067.85 / 448.92 = 2.39

In other words, for EUR 1 of EU contribution for all FCH 2 JU signed H2020 grant agreements until 31 December 2018, the private partners committed to spend EUR 2.39 either on FCH 2 JU projects or on additional activities.

Graph 1.1.1: Comparison of leverage of private investments as at 31 December 2018 compared to targeted amounts as per FCH 2 JU Council Regulation
Committed private and EU contributions for 2014-2018 vs. parity targets 2014-2019



30 Defined in the Council Regulation as minimum leverage to be achieved by members only.

31 Planned EU contribution to FCH 2 JU for the overall H2020 activities.

32 http://ec.europa.eu/research/evaluations/pdf/20171009_a187_swd.pdf, page 44, Table 12.

33 IKAA for 2018 (reported in the Preliminary Report to FCH 2 JU GB as at 31 January 2018), subject to certification by April 2019.

Risk assessment – 2018

In the annual risk management exercise, conducted in October 2018, the FCH 2 JU team assessed risks and responses to those risks in terms of the action plans presented in the AWP 2018.

The aim of the annual exercise was to identify risks that could harm achievements of the FCH objectives, including (among others) operational, financial and compliance risks.

During the exercise, all the risks presented in AWP 2018 were assessed for the following aspects:

- Relevance of the risk -> is the risk still present? Has it materialised?
- Rating of the risk -> did the rating (in terms of impact/likelihood) increase or decrease?
- Relevance and fulfilment of the action plan -> should we continue/expand/reduce action plans?

Based on internal discussions, the risks were either removed (when considered no longer relevant) or modified, while the action plans were reviewed for adequacy and completeness.

The table below provides a summary of the outcome of the discussions on risks and fulfilment of the action plans, as at 31 December 2018:

TABLE 1.1.4: FULFILMENT OF THE ACTION PLANS

RISK IDENTIFIED IN AWP 2018	ACTION PLAN	STATUS AS AT 31 DECEMBER 2018
Due to BREXIT, the participation of UK entities in the programme (currently representing a significant part of FCH 2 JU funding) at the application stage and during project execution can be adversely affected, including fluctuations in project budgets, and commitments from the UK-based companies.	Follow up closely on developments; maintain active dialogue with the EC.	The current risk rating was raised to HIGH due to the more imminent impact on achieving the JU's objectives -> risk of projects becoming ineligible, or even failing; delay in achieving the targets; increased workload for JU staff due to necessity to amend the grants. Action plan to be continued, risk is outside the control/ influence of the JU.
Due to the lean structure of the JU, turnover and/or the lack of key staff may cause business continuity issues.	In case of absence of key staff, FCH 2 JU ensures appropriate back-up solutions in the short term. In the medium-term, FCH 2 JU is prepared to hire short-term temporary contract people (e.g. interims) to ensure full business continuity.	The action plan was expanded in order to respond to long-term solutions, e.g. Seconded National Experts (SNEs).
Timely execution and closure of the *ex-post* audits for H2020 (including less control over H2020 *ex-post* audit process due to the transfer of responsibility to the Central Support Service (CSC) at EC) which could weaken the assurance of the Executive Director.	For H2020 audits, an active dialogue via regular participation on joint Clients of Audits in Research meetings has been established with the common audit support unit at the CSC. The JUs' horizontal issues are addressed by cooperation with other JUs. Timely monitoring and actions are ensured via regular dialogue between the Executive Director and Internal Control and Audit management function.	Experience shows that for coordination purposes, the timing between selection, launch and closure of the audit is longer compared to FP7. For the Declaration of Assurance for 2018 and 2019, mitigating measures were adopted: close monitoring of the execution of the audits with CAS, audit selection in year n-1, more audits launched (i.e. buffers).
Significant representative error rates in H2020 due to fewer *ex-ante* controls. Consequently, the risk of securing a qualified opinion and not getting the discharge from the European Parliament because the Court of Auditors' threshold for representative error rate stays at the level of 2 % (despite the change in the overall H2020 *ex-ante* control strategy for the whole research family).	Introduction of the targeted *ex-ante* controls for the projects/beneficiaries with a higher identified inherent risk. Application of the feedback from *ex-post* audits and lessons learnt from *ex-ante* controls. Reinforcement of the communication campaign with the introduction of financial webinars.	Based on positive preliminary results of the H2020 audits, there is an indication that the representative error rates will remain or even decline compared to FP7. However, due to limited number of results at that date, the rating of the risk remains at medium. Action plans are fully in place and are to be continued; FCH received positive feedback from beneficiaries on the webinars initiative.

RISK IDENTIFIED IN AWP 2018	ACTION PLAN	STATUS AS AT 31 DECEMBER 2018
Leak of confidential data from projects to the public and breach of confidentiality clauses signed by the Authorising Officer with FCH 2 JU beneficiaries due to lack of assurance coming from the CSC in implementation of the dissemination strategy (especially due to the inappropriate design of IT tools, which are supposed to handle confidential data in H2020).	Close follow-up on recent developments in IT tools via participation in the dedicated Dissemination and Exploitation Practitioners Platform working groups. Continuous dialogue with the CSC in order to reach an agreement on the treatment of confidential data and related liabilities.	Action plans set for FCH 2 JU have been fully executed, resulting in the closure of the recommendation and action plans from the IAS service. Dialogue with the CSC will continue in 2019.
Disruption of operations due to the incorrect functioning of the IT tools and IT equipment.	Ensure that the IT tools' new functionalities are properly tested prior to introducing changes in the production environment. Back-up systems are in place to mitigate loss of data. Regular follow-up is performed on the IT tickets raised. Participation in the training for new software and tools introduced via CSC/locally.	Action plan for H2020 tools and workflows was modified, as recent experience shows that JUs are not sufficiently involved in testing the new work flows before they become operational (lack of preventive controls). In case of errors and bugs in the system identified via daily usage, these are reported and addressed promptly by CSC (detective controls). For internally developed tools, proper back-up should be ensured.

The outcome of the 2018 risk assessment workshop on new or continuing risks for 2019 are included in the AWP 2019.

1.2 RESEARCH AND INNOVATION ACTIVITIES

1.2.1 SCIENTIFIC AND TECHNOLOGICAL ACHIEVEMENTS

On the transport side, the FCH 2 JU supported demonstration activities concerning over 1 900 light-duty vehicles, more than 630 of which were already in operation in 2018 (while the others are planned for the coming years within the projects still running). Over the last year, 100 new vehicles were deployed in the H2ME[34] project and 113 in the H2ME2 project, while the SWARM[35] project has been preparing for trials of new hybridised hydrogen-electric vehicles, thereby demonstrating cars produced by European SMEs, such as three next-generation (Riversimple) cars, three microcab and two prototypes of Elano microcar e-mobile. Project HyFive[36] has also continued the demonstration activities of another 143 vehicles.

Based on data collected last year in TRUST (see next chapter) on performance during 2016 and 2017, these vehicles drove at least 3.8 million km for a reported consumption of 33 300 kg of hydrogen. In 2017, the average fuel consumption reported was 1.36 kg per 100 km[37], reporting slightly higher values compared to the previous year, which could be attributed to the introduction of new taxi fleets in Paris, which in general demonstrate a more aggressive consumption (city-driving regime). While the 2020 targets[38] for hydrogen consumption (1.15 kg/100 km) are still to be met by the average fleet, the results for certain fleets already demonstrate consumptions as low as 1 kg/100 km (level of 2030 targets), thereby highlighting the potential for a further reduction in fuel consumption. The average vehicle availability was 99.3 %, which met the 2020 targets (higher than 98 %), while continuing to work to reach the 2020 targets for the fuel cell system cost (60 €/kW) and fuel cell system durability (5 000 h).

To meet the hydrogen refuelling requirements for further European uptake, the necessary infrastructure network is currently being demonstrated and deployed in FCH 2 JU projects, too. The deployment of HRS aims mainly to provide interlinkage across early demonstration sites. The total number of HRS to be supported by FCH 2 JU will reach 99[39], of which 48[40] were deployed in 2018.

34 www.h2me.eu

35 www.swarm-project.eu/

36 www.hyfive.eu/

37 This represents an average fuel consumption calculated by combining the reported driving ranges with the declared fuel consumptions; projects reporting only one of the two parameters were excluded from this average fuel consumption calculation.

38 Targets defined in the MAWP Addendum 2018-2020.

39 Including projects from calls 2008-2017.

40 Including two decommissioned and two pre-deployed stations.

Once projects have finished (along with the grant support), some of the installed HRS are continuing operation under new projects, e.g. HyFive's stations (project finished in March 2018) will be integrated into the H2ME project while SWARM stations (project finished end 2018) will be exploited by the recently started ZEFER[41] project.

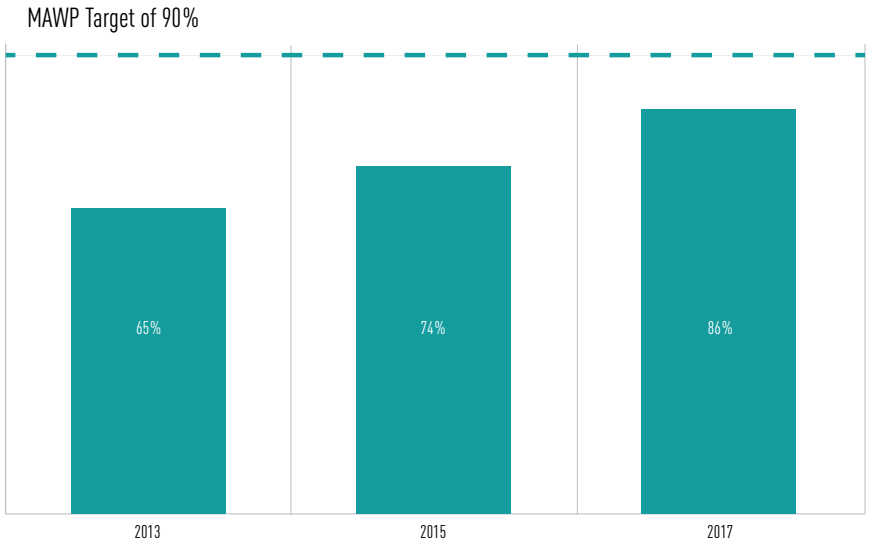
The FCH 2 JU has supported the **HRS network for cars** in 11 countries which delivered 46 738 kg[42] of hydrogen in 2017 (85 % or 39 750 kg of which was 'green' hydrogen) in 8 993 refuelling operations at 96 % availability. This represents an improvement on the previous year (average availability 95 %) as shown in Graph 1.2.2. Furthermore, most of these installations have already met the target for station CAPEX of EUR 1-2.5 million (at a capacity of 200-1 000 kg/day). The cost of green hydrogen (produced via electrolysis from renewables) is reportedly close to 10 €/kg which is below the 2020 MAWP target of 11 €/kg.

A major asset of the FCH 2 JU programme is the increased focus in recent projects on demonstrating the economic benefits (additional revenues) that the **electrolytic production of hydrogen (green hydrogen) at the site of the refuelling station** could offer from services to the electricity grid. In future, this associated revenue generated from the provision of energy services by aggregated electrolyser-HRS systems at the MW scale may contribute to reducing the cost of hydrogen at the dispenser.

FCH 2 JU has also demonstrated 45 **buses** in 10 cities (in operation in 2018), while a total of 310 are planned based on a technology which is now close to commercial reality (at TRL 8). This European FCH bus deployment can be considered as worldwide state-of-art having progressed significantly throughout FCH 2 JU projects. The success of these bus demonstration projects has also been proven by the fact that in different cities, bus operators have joined the projects even after their launch. This also shows the growing involvement of regions and a steady increase in contributions from other sources (private, national, regional, etc.) to financing the demonstration projects.

Based on data collected last year in TRUST on performance during 2016 and 2017 (41 buses reported data), these buses have accumulated a total driven distance of over 6 million km (almost 900 000 km reported in 2017 alone) with over 257 500 kg of hydrogen delivered. In 2017, an average fuel consumption of 9 kg hydrogen per 100 kg was reported, indicating a 9 % reduction compared to the previous year, and on track to reach the 2020 target of 8 kg/100 km. While the 2017 targets for FC system lifetime, FC system cost and vehicle cost (based on procurement prices) have already been met, the consortia are still working on yearly operation costs (16 000 €/kW). The average bus availability has reached the level of 86.6 %, which is seen as remarkable progress compared to previous years and on the perfect track to reach the 2020 target of 90 %.

Graph 1.2.1: Average bus availability for 2013, 2015 and 2017



The necessary **hydrogen-refuelling infrastructure for buses** has also been demonstrated/deployed by 10 stations in 10 cities. These stations have reached an average availability rate of 97 % since the start of their operation, (96 % in 2016 and 98.8 % in 2017) (Table1.1.5). The installed HRS supplied 116 077 kg of hydrogen in 2017 (of which 88 % was green hydrogen or 96 535kg) through 4 850 refuelling operations.

41 https://zefer.eu/

42 This number does not match the 33 000 kg of hydrogen reported above for cars because some FCH-JU-backed HRS are also open to the public and not simply restricted to FCH-JU-backed projects.

TABLE 1.2.1: AVAILABILITY INCREASE IN HRS 2016 VS. 2017

AVAILABILITY OF HYDROGEN REFUELLING STATIONS (HRS)	PROJECTS RESULTS (AVERAGE VALUE)		FCH 2 JU MAWP TARGETS
	2016	2017	2020
Buses refuelling	96	98.8	96
Cars Refuelling	95	96.1	96

Current bus demonstration projects have provided further positive evidence on the performance and functionality of FCH buses and associated refuelling infrastructure, steadily reducing barriers for their commercialisation in the near term. Operational experience has been acquired via different bus drive trains and with different means of hydrogen production. The availability and cost of FCH buses has profited from the experience gained in former projects and are steadily improving with time.

Demonstrations of **material-handling vehicles** (MHVs) from the two ongoing projects HyLIFT-EUROPE[43] and HAWL[44] involved 226 forklift trucks. In 2017 (according to the same data collection in TRUST), 188 MHV covering 10 different MHV models were deployed at 3 sites. These vehicles are technically mature enough for commercialisation, and some EU MHV manufacturers are already offering FCH MHV for the European market. They have accumulated approximately 713 404 hours (h) of operation in total with about 261 168 h in 2017 alone, with 87 300 refuelling operations. The 2020 targets for mean time between failures (750 h) and availability (98 %) has already been achieved (or even surpassed), and the target of 20 000 h lifetime for the MHV has also been proven. The consortia are still working on achieving the cost of on-board hydrogen storage (1 000 €/kg hydrogen), the fuel cell efficiency (50 %) and the fuel cell system cost (1 500 €/kW at 10 kW scale). The two related hydrogen refuelling stations (from the same two projects above), have reported availability levels close to 100 %.

As regards **research-oriented activities for transport applications**, the EU has made considerable progress on the production of state-of-the-art stacks for automotive application. The development activities in the AUTOSTACK CORE[45], INSPIRE[46], and VOLUMETRIQ[47] projects are being scaled up with realistic automotive cell and stack testing being carried out by these projects. Mid-term, they have already met most of the 2017 technical targets set by MAWP, with good prospects of meeting the final targets. In particular, the best-performing projects have achieved an areal power density of 1.13 W/cm^2 and a volumetric power density of 5 kW/l. Platinum group metals (PGM) loadings have also achieved significant progress in recent years with projects achieving a combined anode and cathode minimum of less than around 0.35 g/kW (Graph 1.2.3).

In addition, the DIGIMAN[48], Fit-4-AMandA[49], INLINE[50], INN-BALANCE[51] projects (which only started in 2016-2017) will focus on the development of PEM manufacturing, balance of plant, and quality control practices for transport and MHV applications. Overall, their progress is on track considering the various ad-hoc indicators the projects have to address.

These will build on previous successful projects Nano CAT[52], SMARTCAT[53] and COBRA[54] which have demonstrated good progress at individual component levels, e.g. developing better-performing materials (such as membrane electrode assemblies (MEAs) in the Nano CAT project and catalysts in SMARTCAT) and aiming primarily at reducing platinum (Pt) content and better utilising it while reducing degradation and bipolar plates (COBRA project) for less degradation and greater durability.

43 www.hylift-europe.eu/

44 https://cordis.europa.eu/project/rcn/111022/factsheet/fr

45 http://autostack.zsw-bw.de/index.php?id=1&L=1

46 www.inspire-fuelcell.eu

47 http://www.volumetriq.eu/

48 http://digiman.eu/

49 http://fit-4-amanda.eu/

50 http://inline-project.eu/

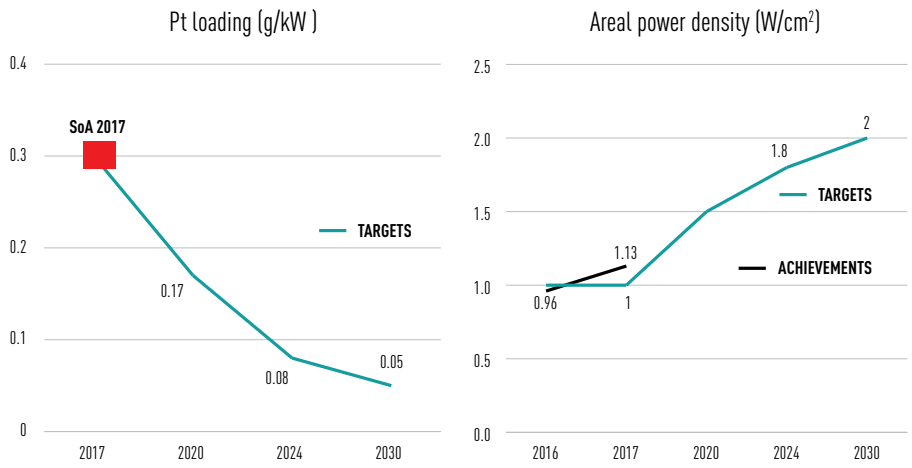
51 https://www.innbalance-fch-project.eu/

52 http://nanocat-project.eu/

53 https://cordis.europa.eu/project/rcn/108627/reporting/en

54 http://www.cobra-fuelcell.eu/

Graph 1.2.2: Platinum loading and areal power density projects results (2017 reference period)



As regards **hydrogen compression at refuelling stations**, the COSMHYC[55] and H2REF[56] projects are currently working towards building and testing a prototype compressor and have great potential for improving the techno-economics for compression (and hence for HRS). It is expected that both projects will contribute to ongoing and upcoming EU and international standardisation activities for hydrogen technologies and refuelling station components.

In terms of **auxiliary power unit (APU)** research and applications, the HYCARUS[57] and MARANDA[58] projects are already meeting their targets at mid-term, which is a good sign that this technology could play a role in the aviation and maritime sectors. Specifically, hydrogen in maritime applications is becoming a topic of great interest due to the regulations in terms of emissions expected in the near future and to the potential advantages for this particular application that hydrogen technologies have, compared to battery technologies.

As regards fuel cells for power production (stationary FC CHP), the relevant FC technology has been steadily demonstrated by FCH 2 JU projects in real installations, while most of targets set in the MAWP have been met. In particular, FCs have shown great potential for residential m-CHP due to their high total and electrical efficiencies, and their ability to run on conventional heating fuels. Technology leaders in this sector (most of them EU heating companies with large markets) are approaching wide commercialisation following extensive field trials of approximately 3 800 units of installed m-CHP FC systems. The ene.field[59] project has installed 1 047 units (both technologies, 604 solid oxide fuel cell (SOFC) and 443 proton exchange membrane fuel cell (PEMFC)) from 10 suppliers in 10 EU Member States (different market conditions). Its successor project, PACE[60] (started in 2017) plans to install another 2 800 units by 2021 (TRL-9) (Graph 1.2.4) and is aiming at a market of 10 000 installations per year after 2022 (59 units installed in 2018). These projects represent Europe's largest deployment of FC mCHP to date and have allowed manufacturers to reduce costs considerably and build alternative heating markets. The availability, electrical efficiency (50-60 %) as well as total efficiency (85-95 %) targets have already been met, while overall the consortium is still working on reaching the sustainability target of 12/13 years lifetime. It is notable, however, that certain deployment trials are already claiming durability which even exceeds the targets set by FCH 2 JU for 2023.

55 https://www.cosmhyc.eu/

56 http://cordis.europa.eu/project/rcn/198235_en.html

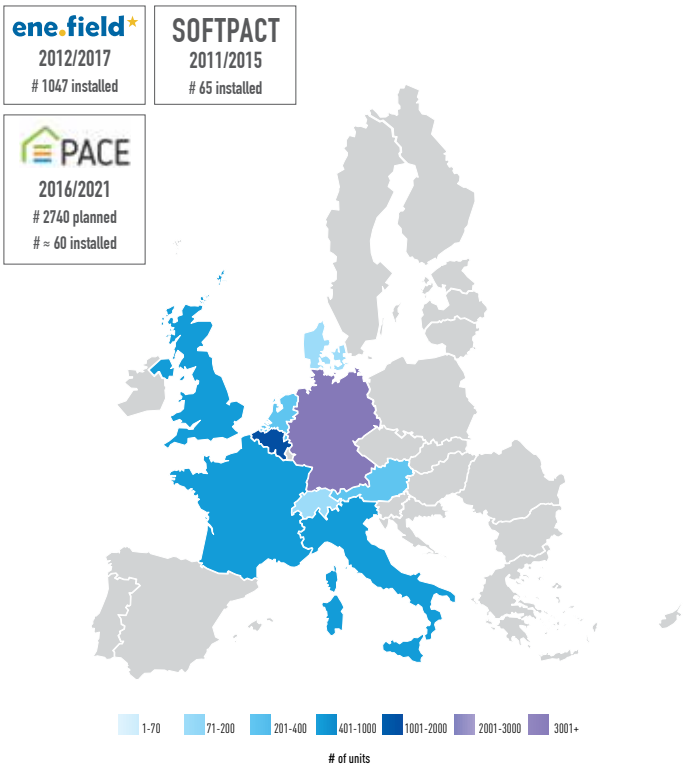
57 http://hycarus.eu/

58 https://www.vtt.fi/sites/maranda

59 http://enefield.eu/

60 http://www.pace-energy.eu

Graph 1.2.3: Mapping of mCHP deployment across Europe



As regards the larger (**industrial size**) demonstrations, the DEMCOPEM-2MW[61] project has demonstrated a CHP PEM fuel cell power plant (2 MWe and 1.5 MWth) integrated into a chlorine-alkali production plant. The hydrogen by-product is used to generate electricity, heat and water for the chlorine-alkali production process, lowering electricity consumption by 20 %. Similarly, the POWER-UP[62] project has demonstrated the first large-scale alkaline fuel plant (200 kW) in the world operating in an industrial setting. In this case, positive experience has been acquired on stack and balance of plant (BoP), supply chain management and manufacturing, and a considerable number of patents have been generated.

As regards the validation of technology (at intermediary technology readiness level), **proof of concept (PoC)** project STAGE-SOFC[63] has developed a prototype of a SOFC system for small-scale CHP and off-grid applications. The first demonstration achieved the electrical power >5 kW AC and electrical efficiency >45 % targets with limited water handling. In addition, the AUTORE[64] project is currently working towards the implementation of a derivative FC system (50-100 kWe) for CHP in commercial and industrial buildings. The component testing has been completed and the demonstration site partially commissioned. The DEMOSOFC[65] project demonstrates the advantages of a commercial-sized SOFC-based CHP system in an industrial environment (waste-water treatment plant in Torino, Italy): last year, the first of three 60 kWe SOFC modules was installed and 2 500 h of operation have been completed, confirming a high electrical efficiency of 50-55 %.

As regards FC CHP research-oriented activities, fuel cell stacks accumulated more than 48 000 hours of operation during 2017 (data collected in TRUST). Supported activities are well balanced across the supply/value chain between system and component design, model development and diagnostics. Significant progress has been reported in terms of the advance of general SoA for SOFC, improved understanding of degradation processes, and the availability of effective diagnostic tools. Here, the effective collaboration between industry and research institutions is most evident, with a high level of SME participation.

61 http://www.demcopem-2mw.eu

62 http://project-power-up.eu/

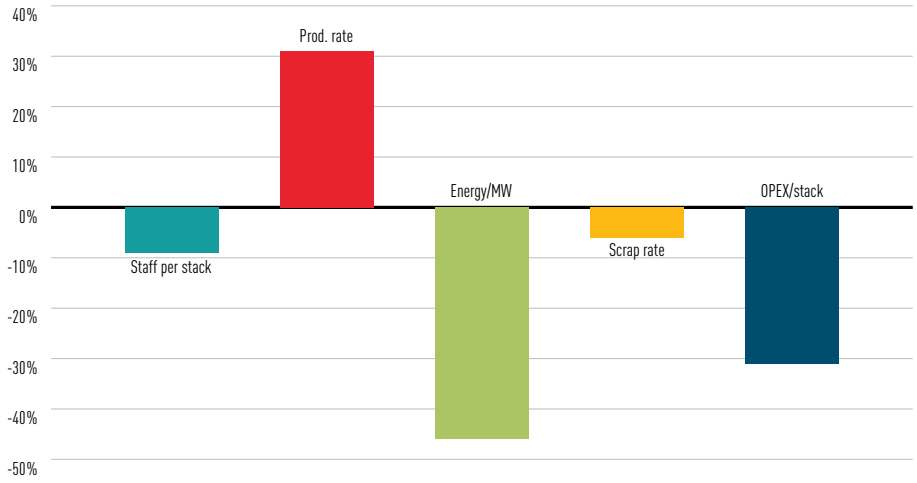
63 http://cordis.europa.eu/project/rcn/185717_en.html

64 https://www.autore-eu.com/

65 http://www.demosofc.eu

With reference to projects working on **next-generation products, degradation, performance and diagnostics**, their key achievements include enhanced understanding of degradation as well as the development of mitigation measures regarding improved sealants, coatings and textured electrodes. The **manufacturing projects** reported electrical efficiency for SOFC of an impressive maximum low heating value of 74 % (average 66 %) at stack level. Fuel utilisation rates of up to 91 % have been achieved with hydrogen. In general, cost reductions for SOFCs have been attained through the further development of manufacturing methods, enabling projected stack costs of 1 000€/kW at mass production. Graph 1.2.5 illustrates the significant improvement in cost reductions between 2016 and 2017 in parallel with better performance in productivity. Platinum loadings in PEMFCs have also been significantly reduced, achieving a 40 % reduction.

Graph 1.2.4: Comparison of manufacturing projects results between 2016 and 2017



Regarding **BoP**, the INNOSOFC[66] project is currently working on the development and demonstration of a 50 kW SOFC system based on an all-EU value chain. It will build upon the successful stack developed by the project NELLHI[67]. Overall, 30 000 h of lifetime, 60 % electrical efficiency (85 % total efficiency) and reduced system complexity are the main reported performances of the developed unit.

As regards activities on **hydrogen production from electrolysis, both at the demonstration and research level**, important technical milestones have been reached for both low-temperature and high-temperature electrolyser technologies. Thanks to the support of the FCH 2 JU programme, electrolysis technology has managed to scale up its capacity over the years, moving from the kW level to the multi MW while inversely decreasing the share of FCH 2 JU support and fostering synergies across EU, regional, national and private funds (Graph 1.2.6).

For **alkaline and PEM electrolysis** projects, the trend towards upscaling the technology continues, as already noted in 2017. In total, 4 MW of alkaline electrolyser capacity is currently demonstrated through Demo4Grid[68] and close to 9 MW of PEM electrolyser capacity through the HyBalance[69], BIG HIT[70] and H2FUTURE[71] projects. This is a marked increase and, upscaling even further, the REFHYNE[72] project will install 10 MW in one site, a German refinery. PEM electrolysers have already reached the 2020 MAWP target regarding energy consumption of 55 kWh at rated power at stack level, substantially improving their performance compared to 2016. Other notable achievements for PEM technology are a very small footprint of 10 m^2/MW (beyond the 2030 MAWP target of 45m^2/MW) and a reduction in the use of PGM to around 3 mg/W (very close to the 2020 MAWP target of 2.7mg/W).

66 www.innosofc.eu/

67 http://www.nellhi.eu/

68 www.demo4grid.eu/

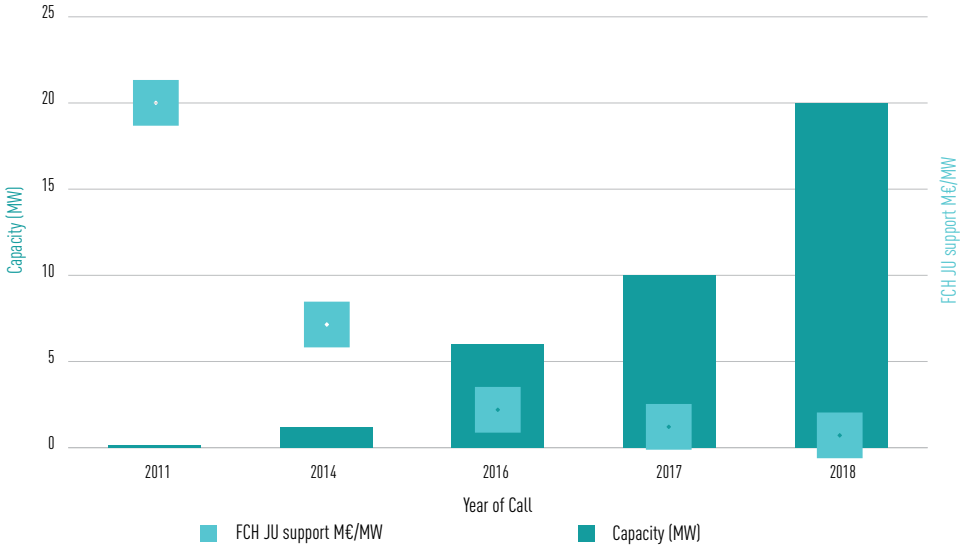
69 www.hybalance.eu

70 www.bighit.eu/

71 www.h2future-project.eu/technology

72 https://refhyne.eu/

Graph 1.2.5: Installed capacity of electrolysers in MW and FCH 2 JU support per MW



Improving the performance of PEM electrolysers to enable them to provide grid services is addressed by the HPEM2GAS[73] project, while the Elyintegration[74] project is investigating the simultaneous provision of hydrogen to industry, e.g. a prototype design for a multi-MW alkaline high-pressure electrolyser is being tested in the relevant environment, a steel plant. The project has already delivered and published an assessment of the regulatory framework regarding grid connection and grid services. Other potential markets are being explored by the ELY4OFF[75] project, which is investigating various business cases. For example, the results show that the cost of competing technologies, such as diesel-based gensets, will always be much lower, which means that cost drivers alone are unlikely to create a market, so the environmental advantages need to be recompensed accordingly (for green technologies).

The first of its kind, the BIG HIT[76] project is demonstrating replicable and integrated hydrogen energy solutions in the Orkney Islands in Scotland. The cornerstones of this project, a 1MW electrolyser, hydrogen trailers, a boiler and fuel cells, and five FC vans were installed last year. The site planning is complete and an HRS has also been commissioned. The project's final objective is to store 970 kg of H2, on track to meet the 2020 MAWP target of 1 000 kg.

As regards **high-temperature (HT) (solid-oxide) electrolysis**, MAWP 2030 targets at stack level are already being met for electricity consumption, with projects reaching electricity consumption values of 33-35.5 kWh/kg. In addition to improving the performance of the technology, projects ECO[77], ELECTRA[78], GrinHy[79], HELMETH[80], SOPHIA[81] and SELySOs[82] are also looking at other modes of operation such as co-electrolysis and reversible operation. The availability of solid oxide electrolyser cell (SOEC) stacks has also improved, with projects reporting no downtimes (during 2018, data collection exercise in TRUST). Advances have been made on capital costs at mass-production level and the MAWP target for production loss rate <1.9 %/1 000 h has already been met at system level.

The large **energy storage capacity of the natural gas grid** is currently being explored by power-to-gas projects producing synthetic natural gas. The HELMETH project is developing a pressurised electrolyser combined with a CO_2-methanation module at high gas conversion ratios. The environmental impact of the process had already been analysed and, as expected, the use of non-fossil CO_2 sources is the more beneficial option. The durability of operating the electrolyser in co-electrolysis mode is being explored by the ECO project, which is getting promising results: electrode optimisation has led to a lowering of the operating temperature by 50-100 °C.

73 www.hpem2gas.eu

74 http://www.elyntegration.eu

75 www.ely4off.eu

76 https://www.bighit.eu/

77 http://www.eco-soec-project.eu/

78 http://www.mn.uio.no/smn/english/research/projects/chemistry/electra/index.html

79 http://www.green-industrial-hydrogen.com/home/

80 http://www.helmeth.eu/

81 http://www.sophia-project.eu/

82 http://selysos.iceht.forth.gr/

In addition, while **using industrial waste heat** (in an industrial environment), there is a potential to produce hydrogen at much lower costs. The GrinHy project is building and operating a high-temperature electrolyser at a steel plant with an existing steam network, producing hydrogen at the purity level required for this application. The project has already achieved an electrical system efficiency of > 80 % LHV and degradation tests at stack level of >10 000 h, with a degradation rate of <1 %/kh.

Aspects of **hydrogen separation or purification** are being addressed by the HyGrid[83] and MEMPHYS[84] projects. HyGrid is working on providing a means of transporting hydrogen produced from renewables by blending it with natural gas before separating it at the location where it is required, while MEMPHYS is targeting electrochemical hydrogen purification with the aim of a high contaminant tolerance at low system cost. The project has already achieved high recovery rates at a low energy consumption of 3 kWh/kg H2 at cell level; with this concept, purification and compression can be achieved in one step.

Finally, as regards **cross-cutting activities, pre-normative research (PNR)** projects are generating a comprehensive understanding of individual aspects of high-pressure storage systems and a solid set of recommendations to be considered for present and future **standardisation activities**. The HyCoRA[85] project has made considerable progress in defining credible potential cost reductions, in reviewing hydrogen impurity mapping, and in developing improved analytical methods. It has also enabled the development of EU laboratories[86] for the required analysis, and successfully engaged with standardisation bodies. In a similar way, the SOCTESQA[87] project has been able to develop, validate and submit to the relevant EU and international standardisation bodies test procedures for performance characterisation of SOFC/stack assembly. These procedures are contributing to the achievement of an EU-wide uniform performance test scheme.

As regards **hydrogen safety**, the HyPactor[88] project has defined a correlation between impact and degradation, enabling progress in inspection and qualification procedures. In addition, the HySEA[89] project, which is studying the behaviour of hydrogen releases in semi-confined spaces by means of full-scale field experiments and validated computer models, has already achieved an impressive collection of experimental evidence enabling a better understanding and the prediction of the phenomena.

Considering the **removal of legal barriers**, for the first time, the HyLAW[90] project has performed a complete analysis of the legal rules applicable to FCH technology deployments at Member-State level, mapping the so-called LAPs. An interactive online database allows for a public, detailed and well-structured assessment of the findings.

Education activities are continuing this year through the KnowHy[91] project which is handing over to the NET-Tools[92] project focusing on the development of new e-education methods based on information and communication technology (ICT) tools, in order to enhance knowledge, productivity and competitiveness.

As regards **sustainability issues**, the pioneering HyTechCycling[93] has been able to identify and classify critical materials in FCs (PEMFC and SOFC) and water electrolysers (alkaline and PEM) and their flows in existing recycling and dismantling technologies.

With respect to **socio-economic** barriers, the Hyacinth[94] project has performed an articulate analysis of public awareness, fears, acceptance of the FCH technologies in the energy and transport sectors, developed a public hydrogen technology acceptance database covering seven countries (Graph 1.2.7) and issued a set of recommendations to raise public awareness and social acceptance.

83 https://www.hygrid-h2.eu/

84 http://www.memphys.eu/

85 http://hycora.eu/

86 as part of HYDRAITE project: https://hydraite.eu/

87 http://www.soctesqa.eu/

88 www.hypactor.eu

89 www.hysea.eu

90 http://www.hylaw.eu/

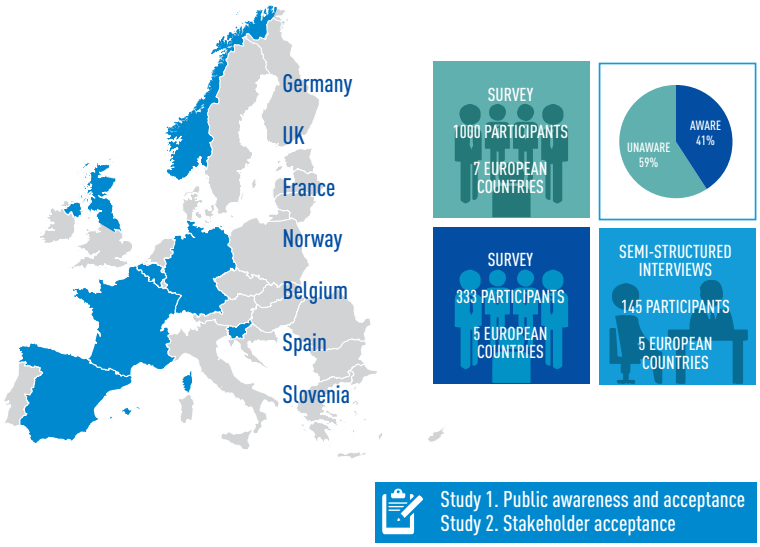
91 http://knowhy.eu/

92 https://www.h2fc-net.eu/

93 www.hytechcycling.eu

94 http://hyacinthproject.eu/

Graph 1.2.6: Scope and activities of the Hyacinth project, the biggest-ever exercise in social research around FCH in Europe



1.2.2 KNOWLEDGE MANAGEMENT

Knowledge management activities have continued with TRUST (Technology reporting using structured templates) being used as the central data-collection tool enabling comprehensive data collection and analysis.

According to the annual planning and in line with their contractual obligations, in May 2018, ongoing projects were requested to provide data concerning their research and innovation results generated in 2017. Consequently, this allowed for assessing the projects' progress against the targets defined in the MAWP 2014-2020[95] (and its Addendum[96] endorsed by the FCH 2 JU GB on 15 June 2018). Horizontal revision of the existing templates (that were developed in 2016/2017) was performed to align the requested parameters with the revised KPIs as introduced in the above-mentioned Addendum. In addition, new templates were created and a total of 22 different questionnaires were used. Project teams answered comprehensive questionnaires (so-called 'templates') according to the type of technologies involved in each project and the related activities carried out.

The data acquired in previous years are archived in TRUST. To date, data from three calendar years have been collected (2015, 2016, 2017) which will soon enable a comparison of the data and the technology's progress over time. The templates can be consulted online at: https://www.fch.europa.eu/projects/knowledge-management

Previous success in terms of data collection continued in 2018: all projects (except two) answered the questionnaires and provided input on most of the queries. In 2018, TRUST data collection activities were streamlined with the annual programme review exercise. This allowed the knowledge management team and project officers as well as the JRC to analyse the results and include them as content during the portfolio analysis part of the Programme Review 2018 (report currently being finalised) as well as in the Programme Review Days event. Projects were encouraged to open up the data (make public the relevant KPIs) as much as possible, while all confidential data were appropriately cleaned and anonymised.

Updating the internal database, which contains overall plans and deployments in Europe, continued in 2018. This database was fed with information from projects and from general/specific press coverage concerning the plans for and deployment of FCH technologies, such as electrolysers, vehicles, HRS and stationary units, including detailed information on country, size, technology, etc. Information from other parts of the world may also be included for benchmarking. In particular, for cars, this is complemented with reference to FC-car deployment figures (passenger car data only) from the European Automobile Manufacturers' Association (ACEA) recorded on a quarterly basis, as obtained directly from the ACEA. Where possible, vehicle sales figures are now being captured every six months from the vehicle manufacturers themselves. As the data per manufacturer are treated as confidential, only aggregated values (EU/country) are being disclosed.

95 www.fch.europa.eu/sites/default/files/FCH%202%20JU%20MAWP-%20final%20%28ID%204221004%29.pdf

96 www.fch.europa.eu/sites/default/files/MAWP%20final%20version_endorsed%20GB%2015062018%20%28ID%203712421%29.pdf

As part of the JRC's Rolling Plans 2017 and 2018, an FCH-adapted TIM[97] database was developed. Scientific publications, patents, participation in projects and others were mapped according to authors' organisations, and three FCH datasets were created including alkaline, solid oxide and PEM technologies. In addition, an FCH 2 JU dataset was developed including only information from FCH 2 JU beneficiaries, while across all universes FCH 2 JU information was isolated on related beneficiaries' contributions only, from which users can further tag and filter FCH 2 JU beneficiaries and publications related to FCH 2 JU projects. This should enable developments in FCH technologies and the related impact of FCH 2 JU funding to be tracked. A dedicated webpage is currently being developed on the FCH 2 JU website to host and make available to the community these related TIM spaces.

1.2.3 RCS SC GROUP ACTIVITIES

The industry-led Regulations, Codes and Standards Strategy Coordination (RCS SC) group, composed of 18 representatives of private members Hydrogen Europe and Hydrogen Europe Research, is supported by the European Commission's JRC and the FCH 2 JU programme office. The RCS SCG coordinates the strategy on RCS, with a focus on identifying strategic themes for RCS development and their proposed follow-up. The goal of this work is to provide the FCH 2 JU programme with an evidence-based analysis of urgent priorities for PNR and standardisation needs supporting the design of future annual work plans.

In order to identify the strategic priorities for PNR and RCS topics, the ongoing PNR activities of FCH 2 JU project portfolios are constantly reviewed. In addition, projects and initiatives at international or Member-State level are taken into account, as well as the findings of other relevant initiatives through input from members. Other sources of information considered are the draft report of the Sector Forum Energy Management Working Group Hydrogen (SFEM WG H2) and the outcomes of the bi-annual workshop on research priorities in hydrogen safety organised by the HySafe[98] project, JRC and the US Department of Energy (DoE).

Mapping of the PNR and RCS progress achieved so far by FCH 2 JU projects was performed by the JRC as input to the review and gap analysis. This also included a review of relevant project recommendations concerning PNR and RCS. The outcome of the gap analysis was used by members of the RCS SCG to identify both overarching strategic themes and specific challenges.

The overarching priorities are the public use of hydrogen, hydrogen interoperability, hydrogen valorisation and ensuring the competitiveness of EU industry. The specific challenges related to the overarching themes are updated annually and prioritised through a voting process among RCS SCG members. The outcome of this work has been provided to the FCH 2 JU in a dedicated report, to be considered as input on strategic PNR and RCS priorities to the AWP2019-2020 drafting process.

Among other group activities in 2018 was a contribution to the Annual Union Work Programme for European Standardisation (AUWP) on enabling standards for waterborne applications. These standards are necessary to support the uptake of FCH in the maritime sector. This proposal was included in the AUWP 2019, which is drawn up on an annual basis by the EC.

Three in-person meetings were held during the year, during which the RCS SCG further refined its objectives to include transferring and ensuring the use of PNR results in RCS development, and establishing an approach to enhance European participation and influence in European and international standardisation fora. Implementation of these two additional tasks will be explored in 2019.

1.2.4 EUROPEAN HYDROGEN SAFETY PANEL (EHSP)

The FCH 2 JU launched the European Hydrogen Safety Panel (EHSP) initiative in 2017. The mission of the EHSP is to help the FCH 2 JU both at programme and at project level to ensure that hydrogen safety is adequately managed, and to promote and disseminate the H2 safety culture both within and outside of the FCH 2 JU programme.

The EHSP comprises a multidisciplinary pool of experts – 17 experts in 2018 – grouped in small ad-hoc working groups (task forces) according to the tasks to be performed and the expertise required. Collectively, the members of the EHSP have the necessary scientific competencies and expertise to cover the technical domain needed to make science-based recommendations to the FCH 2 JU.

In 2018, the EHSP operational activities were kicked-off and, following the structure and preliminary activities of the EHSP defined in 2017, four task forces were launched. Here is a summary of the activities the Panel performed during 2018:

97 http://www.timanalytics.eu/

98 http://www.hysafe.org/

Support at project level: As learning from others and referring to best practice is an essential element of a high-level safety culture, in 2018, the EHSP released a safety guidance document for FCH projects and programmes in Europe. These guidelines – the first of a kind – aim to support Europe in identifying the minimum safety requirements, hazards and associated risks and to generate a quality safety plan that will help guide inherently safer conduct of all work related to the development and operation of FCH systems and infrastructure in Europe. The document, which will be publicly available on the EHSP webpage at the beginning of 2019, it provides information on safety planning, monitoring and reporting for the FCH projects (and programmes) concerned, providing an integrated approach to project safety planning, monitoring and reporting needs to best address technical and organisational aspects related to hydrogen safety.

Support at programme level: In 2018, the EHSP supported the FCH 2 JU in identifying safety issues and research which may still require support within the programme in order to better understand and assess – as part of the continuous watch function on European and global developments in the hydrogen safety field – current and near future needs in hydrogen safety. As a result of these activities, a report has been drafted on the research priorities for hydrogen safety, which will be released in 2019. Furthermore, during 2018, the EHSP discussed potential activities for the coming years, paving the way to formulating a multi-annual work plan for the EHSP, expected for 2019.

Data collection and assessment: During 2018, EHSP activities in this category encompassed the analysis of safety data and events contained in the revamped European Hydrogen Safety Reference Database (HIAD 2.0) operated by the JRC and supported by the FCH 2 JU. In close collaboration with the JRC, the EHSP members systematically reviewed more than 250 events; the lessons learned from this assessment will be released as a report in 2019 to provide a clear view about the current situation in Europe regarding the Hydrogen Safety Reference Database, while providing the foundations for future research in this field. Moreover, and related to the activities of the previous task force, a dedicated set of activities during the year focused on reviewing the contribution to date of the FCH 2 JU programme on safety aspects, providing a clear baseline for drafting the envisaged multi-annual work plan for the EHSP.

Public outreach: Framed within the context of the intended broad information exchange, a dedicated webpage about the EHSP initiative was hosted on the FCH 2 JU website in 2018, and potential communication channels for maximising the effectiveness of the outreach of EHSP activities were discussed, paving the way to develop over the coming year a comprehensive and practical communication strategy.

1.2.5 COLLABORATION WITH THE JRC – ROLLING PLANS 2017-2018

The Commission's Joint Research Centre undertakes high-quality research in the FCH field which is of considerable relevance to the implementation of FCH 2 JU activities. During FP7, cooperation between the JRC and FCH JU was structured under a Framework Agreement covering support activities which the JRC provided in-kind to FCH JU, as well as possible funded JRC participation in FCH JU projects.

For Horizon 2020, a Framework Contract between FCH 2 JU and the JRC was approved by the GB on 23 December 2015, including the first Rolling Plan 2016 as its annex, and signed by both parties on 18 February 2016. Contrary to the situation under FP7, JRC involvement in FCH 2 JU-funded projects outside of the Horizon 2020 Rules for Participation is not possible. Thus, the scope of the Framework Contract does not cover the JRC's participation in FCH 2 JU-funded projects but does include the activities it will provide at the FCH 2 JU programme level. These support activities are covered by the Framework Contract are outlined in annual Rolling Plans. The annual Rolling Plan 2018 was part of the AWP 2018 and described the annual activities and their related deliverables provided against payment by the JRC to the FCH 2 JU (heading B of Article 2 in the Framework Contract). Additional activities which the JRC performs without payment (heading A in Article 2) were not listed. JRC activities in 2018 followed this plan and will be reported before the end of February 2019.

For 2018, an indicative budget of EUR 900 000 (maximum of EUR 1 million) was foreseen from the FCH 2 JU operational budget. JRC support activities for the FCH 2 JU programme covered by the Framework Contract were discussed and agreed between the JRC and the programme office, with the involvement of a representative from Hydrogen Europe and Hydrogen Europe Research.

In line with the JRC's mission, these support activities have primarily contributed to the formulation and implementation of the FCH 2 JU strategy and activities in the areas of RCS, safety, harmonisation of testing protocols and technology monitoring and assessment. In addition, the programme office may call upon the JRC to perform testing as a service to the FCH 2 JU, providing added value to programme objectives by complementing the activities of FCH 2 JU-funded projects.

JRC support to formulation and implementation of RCS strategy

The industry-led RCS SC Group is assisted by the JRC and the FCH 2 JU programme office. In 2018, JRC continued to support the RCS SC Group, as in previous years, notably contributing with a gap analysis on RCS and PNR. Moreover, JRC activities were extended compared to previous years, and in 2018, it also undertook a steering role as coordinator of the RCS SC Group, in support of the chair, co-chair and the programme office. Linked to this activity and in addition to the day-to-day support of the RCS SC Group activities, the JRC drafted the RCS SC Group's work plan 2018 (strategy implementation, timeline, methodological approach) and played a key role in the Group activities for the selection and proposal of potential topics for the FCH 2 JU AWP 2019.

As regards hydrogen in waterborne applications, the JRC proposed a standardisation request, in collaboration with the RCS SC Group, for development/revision of harmonised European standards in support of EU legislation, which has been included in the Annual Union work programme for European standardisation for 2019.

JRC's direct contribution to implementing RCS strategy

Regarding harmonisation activities for the development of the harmonised test hardware for single cell PEMFC testing, the JRC updated and performed validation tests before the adoption of a final hardware design. The hardware will ensure that the MEAs tested are exposed to the same conditions without any influence of the hardware set-up. This work has been elaborated in cooperation with international stakeholders. Similarly, the JRC has been coordinating the harmonisation of electrolyser testing whereby the terminology and protocols for single cell and stack testing have been completed for low-temperature electrolysers.

JRC's contribution to programme monitoring and assessment

JRC has been working closely with the knowledge management team in terms of developing the TIM tool (see Section 1.2.2.) to create a customised FCH technology monitoring system. In addition, the JRC performed the annual programme review (see Section 1.5.2.) and issued a report on the findings. This report was used to prepare the public version of the annual programme review report.

It also delivered a report providing an inventory of work performed by projects funded under FCH 2 JU, covering 40 reports on LCA performed on a wide scope of technologies and processes by FCH 2 JU projects.

JRC's contribution to safety and safety awareness

Moreover, in previous Framework Programmes, the JRC built and populated the Hydrogen Incidents and Accidents Database (HIAD), collecting safety-related events concerning hydrogen technologies applications. HIAD is the optimal tool for a repository of safety information generated by the FCH 2 JU programme, including communication, lessons learned and safety improvement dimensions.

In the framework of the FCH 2 JU strategy on safety aspects at programme level, the FCH 2 JU decided to make use of this revamped database (HIAD 2.0) managed by the JRC and supported by the FCH 2 JU. In 2018, besides the work performed in HIAD 2.0, the JRC also worked on the FCH 2 JU proprietary database HELLEN (Hydrogen Event Lessons LEarNed). This is a tailored version of HIAD2.0 to be used as a multi-purpose tool and the repository of safety information generated by FCH 2 JU projects, while providing lessons learned and safety improvement recommendations. As a result of these activities, the JRC issued a deliverable concerning HELLEN's operation: the population of HELLEN with events delivered by projects and the annual report.

In 2018, the JRC also played an active supporting role for the European Hydrogen Safety Panel (EHSP, see action D), in particular in Task D2: support at programme level, and Task D3: data collection and assessment. In Task D2, its main contribution was as co-author of the deliverable: 'European Hydrogen Safety Panel annual report on research priorities in hydrogen safety', as a result of a multi-annual effort to identify scientific and technical knowledge gaps for hydrogen. In Task D3, the JRC had a key role in the review and analyses performed by the EHSP of almost all the 272 events available in the revamped HAID 2.0, helping to derive lessons learned from these events.

The JRC has represented the EC in the IEA Hydrogen Implementing Agreement, participating in Task 38 (Power to Hydrogen and Hydrogen to X) and Task 39 (Maritime Transport). As regards the former, and with the support of FCH 2 JU, it provided input on existing demo projects and performed an assessment of current studies while working actively on the legal framework and barriers. In addition, within the framework of the International Partnership for Hydrogen into the Economy (IPHE), the JRC exchanges views and aligns strategy with the FCH 2 JU.

1.2.6 SUPPORT TO POLICIES AND FUNDING/FINANCIAL ENGINEERING OF THE FCH 2 JU

The FCH 2 JU is contributing to the activities of a number of services in the EC. Contributions vary in content and format, but they all share the common goal of providing fact-based information on the state-of-art of FCH technologies and their contribution to EU initiatives and policies, especially in the energy, transport and industry sectors as well as to competitiveness and growth.

In practical terms, during 2018, this meant taking part in a number of technical groups organised by the EC and other international bodies, taking an active role during the meetings, providing written technical input and ensuring that FCH technologies are properly represented in the relevant sectors.

As in previous years, supporting Directorates-General (DGs) ENER, RTD, MOVE and CLIMA, the FCH 2 JU continued to actively follow and contribute to the European Strategic Energy Technology Plan (SET-Plan) activities during 2018, Action 6 'Energy Efficiency for Industry' and Action 8 on 'Renewable Fuels'. The Implementation Actions of Action 6 were finalised in 2017 and in 2018 emphasis was placed in identifying ways to finance these actions in the various industrial sectors. The FCH 2 JU participated in a number of workshops. In 2018, Action 8 worked to prepare its implementation plan which was approved in June the same year. The FCH 2 JU participated in Action Group 8 meetings and contributed to the compilation of the Implementation Plan.

During 2018, the FCH 2 JU extended its exchanges with DG ENV, especially those following the policy file on the circular economy. At the end of the year there were also early contacts with those in charge of air quality policies in DG ENV. The FCH 2 JU intends to intensify these exchanges during 2019.

Also, in 2018, for stationary applications of fuel cells in the building sector, the FCH 2 JU strengthened links with those in charge of the EC contractual Public Private Partnership Energy Efficient in Buildings (cPPP EeB)[99]. Exchanges have taken place with both the EC and industry representatives of the construction sector. In particular, the FHC 2 JU presented its activities to the Steering Committee of the European Construction Technology Platform[100] (ECTP).

During 2018, the FCH 2 JU continued participating as an observer in several of the subgroups of the ART Fuels Forum established under the project 'Support for alternative and renewable liquid and gaseous fuels forum[101] (policy and market issues)'. It also attended the Second Governing Board of the Strategic Transport Research and Innovation Agenda (STRIA) and offered its availability for the update of the alternative fuels roadmap, due to be updated in 2019. Still in the domain of transport, in 2018, the FCH 2 JU continued to play an active role in the Clean Bus Deployment Initiative launched by DG MOVE, as a member of its Clean Bus Expert Group. The latter provides support to the Clean Bus Deployment Platform, producing technical reports with specific policy recommendations and financing topics related to the deployment of clean buses. While its conclusions will be shared at the plenary meetings of the Sustainable Energy Forum, the FCH 2 JU input for the year to come is expected to shift to the setting up of the Clean Bus Deployment Platform, providing insights on the pipeline of projects to deploy Fuel Cell Electric Buses (FCEB) in Europe.

The FCH 2 JU continues to support the JRC by taking part in the activities of the International Energy Agency Hydrogen Implementing Agreement in Task 38 on Power to Hydrogen and Hydrogen to X and Task 39 on Marine applications (see the JRC and International cooperation chapters).

FCH 2 JU support to EC policymakers goes beyond energy and transport policies. Supporting EU objectives for sustainable growth and innovation, the FCH 2 JU Study on Value Chain and Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cells Technologies continues to be used by DG GROW as an evidence base on how the FCH sector could contribute to strengthening and reinforcing the competitiveness of EU industry. In particular, during 2018, the results of the study were used as inputs to the work DG GROW is doing in response to the call for applications for the Strategic Forum for Important Projects of Common European Interest[102].

99 http://ec.europa.eu/research/industrial_technologies/energy-efficient-buildings_en.html

100 http://e2b.ectp.org/

101 http://artfuelsforum.eu/

102 http://ec.europa.eu/newsroom/growth/item-detail.cfm?item_id=613374

The FCH 2 JU is also conducting a study on developing a guarantees of origin scheme for hydrogen with a strong focus on ensuring its alignment with the foreseen regulatory frameworks at EU level (e.g. RED II) as well as with other European standardisation efforts. This will continue in an effort to ensure that the green and low-carbon definitions are taken up in EU legislation, such as the forthcoming delegated acts referred to in RED II. Furthermore, an effort will be made to ensure that the tracking system that has been developed can be used to issue both guarantees of origin and certifications of compliance with RED II for the fuels obligation (Art. 25).

In the maritime sector, the absence of regulation, code and standards (RCS) for hydrogen as a maritime fuel has been the core subject of regular exchanges between the FCH 2 JU, DG RTD, DG MOVE, EMSA and the JRC. In the framework of the Valletta Declaration 'Priorities for the EU's maritime transport policy until 2020', and in support of new or existing legislation and policies, the JRC has proposed standardisation actions easing the uptake of FCH in the maritime sector for the Annual Union Work Programme 2019. The origin of that initiative is the FCH 2 JU MARANDA project.

The FCH 2 JU has continued exchanges to include executive agencies charged with managing other parts of Horizon 2020 in areas relevant to FCH technologies. For example, in the transport sector, the FCH 2 JU continues to work with the Innovation and Networks Executive Agency (INEA) on activities related to FC buses and HRS. In the energy sector, 2018 saw close collaboration with those in the Executive Agency for Small and Medium-sized Enterprises (EASME) supporting activities on the circular economy, which brought the FCH community closer to new stakeholders. In addition, EASME representatives presented to the FCH Regions Initiative stakeholders the instruments and initiatives they manage in order to support regional and local public authorities[103].

In addition, during 2018, the FCH 2 JU presented the state of the art on civil applications of FCH technologies developed by its projects to the stakeholders of the European Defence Agency (EDA), in particular MS representatives. This was done at several technical workshops managed by the EDA as well as during the two bi-yearly Conferences of the Consultation Forum for Sustainable Energy in the Defence and Security Sector Phase II (CF SEDSS II[104]). This has helped to open up the debate on the role of hydrogen in the decarbonisation and self-sufficiency of military buildings, camps and vehicle fleets.

Building on the activities undertaken in 2017, the collaboration with the JRC as regards boosting synergies with the European Structural and Investment Funds (ESIF) in chosen research areas and industrial activities which started in 2017 all resulted in a matchmaking event in March 2018. This was organised by the JRC in collaboration with DG REGIO, the European Parliament, the European Committee of the Regions, three Joint Undertakings (FCH, Clean Sky and BBI) and a number of regional and national ESIF managing authorities. The JRC will publish a technical report on the analysis of collaboration mechanisms of JUs with ESI Funds in an S3 context on the back of this event during Q1-2019. Also, under the framework of the FCH Regions Initiative, the FCH 2 JU has continued to work closely with the JRC with the aim of setting up an FCH partnership as part of the Smart Specialisation Platform[105]. This work is ongoing. The FCH Regions Initiative's bottom-up approach has encouraged local and regional governments to include FCH in their regional priorities when managing certain ESIF. Under this initiative, an IT funding tool was developed and made available online, enabling detailed analysis of existing EU grant funding opportunities on a simple and user-friendly platform. While this tool is designed to provide support for the deployment of FCH technologies projects by regions and cities (the initiative's target stakeholders), it is also expected to benefit the beneficiaries of FCH 2 JU calls for proposals, enabling them to better navigate the array of EU funds available in different regions and Member States. Leveraging on these two initiatives – i.e. the FCH Regions Initiative and the JRC matchmaking event – its recommendations are shaping some of the activities proposed by the FCH 2 JU for 2019, namely: (i) the inclusion of a topic in the 2019 call for proposals to develop hydrogen valleys; (ii) establishing stronger links and relationships with countries and regions managing EU funds; (3) providing assistance on the use of other existing EU funding sources for project implementation (also applicable to projects that are not selected within the hydrogen valleys topic in the 2019 call for proposals, on a project-based collaboration approach); and (iv) the launch of a project development assistance facility to help develop detailed project plans in regions and cities, with special attention to Central and Eastern Europe.

With the aim of accelerating the market introduction and deployment of the technologies stemming from the projects FCH 2 JU is supporting, funding/financial engineering activities are becoming an FCH 2 JU core activity. The JU is now providing advice and support to prospective or past beneficiaries of FCH 2 JU projects in order to combine funding from various programmes and optimise structured finance operations.

The Undertaking has been working with and establishing a close relationship with several European Investment Bank (EIB) departments, namely the InnovFin EDP/InnovFin advisory hub; Equity, new products and special transactions; Growth capital and innovation finance; and transport operations.

103 See, for instance, http://www.managenergy.eu/, https://ec.europa.eu/easme/en/section/horizon-2020-energy-efficiency/public-authorities and https://ec.europa.eu/easme/en/section/horizon-2020-energy-efficiency/finance-and-services-sustainable-energy

104 https://www.eda.europa.eu/european-defence-energy-network

105 http://s3platform.jrc.ec.europa.eu/home

Acknowledging that in terms of funding structure there is no one-size-fits-all approach, the FCH 2 JU has launched a dedicated webpage on funding and financing to harmonise and aggregate the sources of information and lessons learnt. Despite its intrinsic dynamic nature requiring a regular update, the site is set to be become a repository of IT tools and studies that: (i) raise awareness on the technology; (ii) provide clarity on the viability of investments; and (iii) reveal the funding and financing available to support the deployment of FCH technologies. The webpage is now an entrance for new project promoters as well as a market enabler for beneficiaries of FCH 2 JU calls, giving them the guidance and initial support required for the materialisation of investments.

The FCH 2 JU will continue to work with the EIB and the industry to facilitate access to financial instruments, such as the InnovFin EDP or others being used for de-risking projects which have access to the European Fund for Strategic Investments (EFSI).

It is essential that the finance community becomes and remains fully aware of the state of the art in terms of FCH technology solutions (via the results of FCH 2 JU projects), their market readiness, the benefits they bring, and the impacts they may achieve through the provision of private-sector funding and financing support (across the spectrum of new entrants, start-ups, SMEs and established firms in the FCH market place). With the aim of raising the profile of our beneficiaries' products and solutions, thereby addressing the private-sector funding and financing challenge that acts as a market barrier for the deployment of FCH technologies and the wider FCH integrated solutions, as mentioned before, the FCH 2 JU together with DG RTD and their Support Services for Exploitation of Research Results (SSERR) initiated a pilot brokerage event that culminated with the pitching of results by trained representatives of our project beneficiaries during the PRD2018 event.

Regions initiative

The FCH 2 JU has committed to working with the regions to raise awareness of FCH technologies. This commitment to the regions has produced a wealth of up-to-date information (available on the FCH 2 JU website) and a final report, which include:

- Analysis of the business cases for FCH applications that local authorities are seeking
- Assessment of the overall set of potential projects to be implemented by regional and municipal authorities, totalling over EUR 1.8 billion over the next five years
- Identifying existing funding sources for future project implementation.

To date, 92 regions and cities wanting to participate in the activities have signed a memorandum of understanding (MoU). In 2018, one of the main activities was the organisation of local workshops promoting the exchange of knowledge on best practices in FCH project development and discussions on the best way for European cities and regions to implement such projects. Two workshops were organised in each of the six regional clusters {UK (London and Edinburgh), South and Eastern Europe (Athens and Sofia), Central Europe (Leipzig and Groningen), Nordics and Baltics (Oslo and Mariestad), Iberia and Italy (Puertollano and Santander) and France (Paris)} as well as two 'H^2 valley' workshops (Frankfurt and Amsterdam).

Looking forward, the FCH 2 JU looks to further develop the cooperation in a number of different ways:

- Inclusion of a topic in its 2019 call for proposals to develop hydrogen valleys
- Launch of a project development assistance facility to help develop detailed project plans in regions and cities, with special attention to Central and Eastern Europe
- Potential creation of a new FCH energy partnership under the Smart Specialisation Platform
- Assistance in the use of existing funding sources for the implementation of projects.

1.2.7 INTERNATIONAL COOPERATION

Given the importance of international cooperation in science and technology, explicitly recognised in the EU's Innovation Union flagship initiative[106] and the Horizon 2020 programme, and described in the Communication 'Enhancing and focusing EU international cooperation in research and innovation: a strategic approach'[107], the FCH 2 JU has continued to be active at the international level, in order to align with, facilitate and accelerate the worldwide market introduction of FCH technologies.

As the deployment of FCH technology is carried out globally and key partners of the FCH 2 JU are involved in these developments, the JU has continued to develop links with the major deployment programmes globally, mainly through the IPHE but also through periodic bilateral discussions with the US DoE, Japan METI/NEDO (Ministry of Energy and Transport) and the recently launched Mission Innovation – Innovation Challenge 8: Renewable and Clean Hydrogen[108] to harmonise standards and regulations and to accelerate market preparation.

In particular, FCH 2 JU has collaborated closely with EC representatives on the IEA Hydrogen Technology Collaboration Programme (TCP) executive committee to optimise and share the effort and participation. With particular reference to the IEA tasks related to power-to-x and maritime applications, FCH 2 JU has continued to provide scientific and technical expertise aligned with MS representatives and FCH 2 JU-funded projects.

It has continued to exchange best practice with the US DoE among other reviewers during both the US DoE Annual Merit Review and the FCH 2 JU proposal evaluations (both in June 2018). Moreover, it has also collaborated with EC representatives in support of the Mission Innovation activities (Innovation Challenge 8), participating to the first working workshop in Berlin (October 2018). Of special interest in all of these discussions were mainly the regulatory and policy frameworks, socio-economic and environmental assessments, LCA, RCS, safety, development of common methodologies for monitoring large-scale demonstrations and alternative technical solutions, and/or options considered for measuring hydrogen purity, hydrogen cooling and hydrogen dispensing, as well as addressing the global issues of hydrogen logistics/carriers.

1.3 CALLS FOR PROPOSALS AND GRANT INFORMATION

1.3.1 PROPOSALS

The 2018 call for proposals was published on 16 January 2018, and included, in accordance with the AWP 2018, 20 topics: 7 in the transport pillar, 8 in the energy pillar, 1 in overarching activities, and 4 in cross-cutting activities, with an indicative budget of EUR 73.2 million. The call closed on 24 April 2018.

On 26 January 2018, a public information day was organised in Brussels.

The 2018 call received 61 proposals: the results of the evaluation of these proposals are presented in paragraph 1.3.2. All consortia were informed of the evaluation results at the same time, 114 days (TTI) after the closure of the call, well in advance of the TTI target fixed by the Commission (153 days). Immediately after the information had been sent out, preparation of the GAs began. 17 of the 19 GAs were signed in 2018 in 230 days on average and before the TTG target fixed by the EC, i.e. 243 days after the closure of the call. The remaining 2 GAs requested an extension of the TTG deadline, due to exceptional circumstances.

106 https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/innovation-union_en

107 https://ec.europa.eu/research/iscp/pdf/policy/com_2012_497_communication_from_commission_to_inst_en.pdf

108 http://mission-innovation.net/our-work/innovation-challenges/renewable-and-clean-hydrogen/

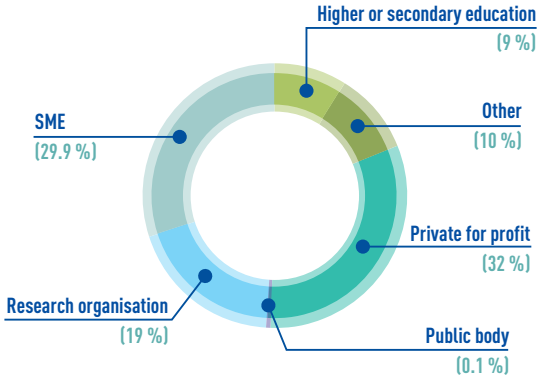
TABLE 1.3.1: CALL 2018 – TIME TO SIGN AND GRANT

CALL	PROPOSAL NUMBER	ACRONYM	TTI	TTS	TTG
H2020-JTI-FCH-2018-1	824953	RoRePower	114	110	224
H2020-JTI-FCH-2018-1	825027	AD ASTRA	114	118	232
H2020-JTI-FCH-2018-1	826056	WIND2HYRAIL	114	*ongoing*	*ongoing*
H2020-JTI-FCH-2018-1	826097	GAIA	114	119	233
H2020-JTI-FCH-2018-1	826161	WASTE2GRIDS	114	119	233
H2020-JTI-FCH-2018-1	826193	HyTunnel-CS	114	113	227
H2020-JTI-FCH-2018-1	826204	DOLPHIN	114	119	233
H2020-JTI-FCH-2018-1	826215	FLAGSHIPS	114	109	223
H2020-JTI-FCH-2018-1	826234	WASTE2WATTS	114	119	233
H2020-JTI-FCH-2018-1	826236	H2Haul	114	*ongoing*	*ongoing*
H2020-JTI-FCH-2018-1	826246	FCHgo	114	117	231
H2020-JTI-FCH-2018-1	826247	HEAVEN	114	117	231
H2020-JTI-FCH-2018-1	826262	THOR	114	125	239
H2020-JTI-FCH-2018-1	826323	LOWCOST-IC	114	117	231
H2020-JTI-FCH-2018-1	826339	H2Ports	114	118	232
H2020-JTI-FCH-2018-1	826350	GrInHy2.0	114	118	232
H2020-JTI-FCH-2018-1	826352	HyCARE	114	109	223
H2020-JTI-FCH-2018-1	826379	HYDROSOL-beyond	114	109	223

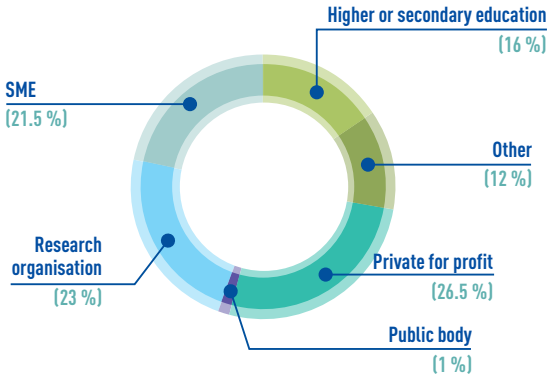
The 17 projects listed above (+ 2 expected to be signed in Q1 2019) include 158 participations for a total FCH 2 JU contribution of EUR 71.6 million.

The figures below indicate the distribution of the number of participants and the FCH 2 JU contribution by participant category.

Graph 1.3.1: Breakdown of contribution by participant category (in EUR)

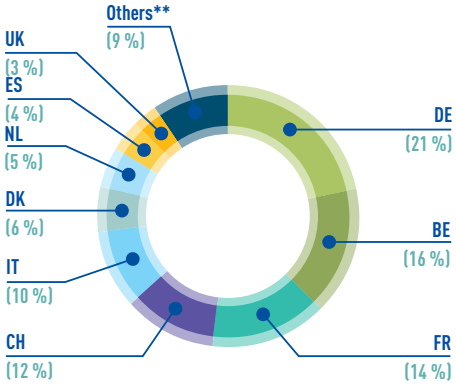


Graph 1.3.2: Breakdown of participant category (by legal type)

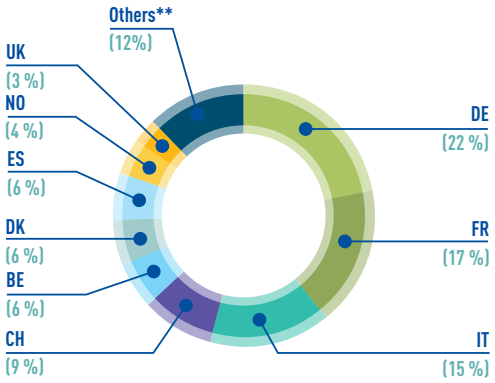


Beneficiaries from 19 EU MS or Associated Countries are participating in the 19 projects and have already received or will receive funding. The figures below indicate the distribution of the participants and the FCH 2 JU contribution by country.

Graph 1.3.3: FCH contribution by country (in EUR)



Graph 1.3.4: Number of participants by country



* NO 3 % – FI 2.6 % – EL 1.1 % – SI 0.8 % – AT 0.6 % – SE 0.6 % – BG 0.3 % – CZ 0.2 % – PL 0.1 % - US 0 %
** FI 2.5 % – NL 2.5 % – AT 1.2 % – EL 1.2 % – SE 1.2 % – BG 0.6 % – CZ 0.6 % – PL 0.6 % – SI 0.6 % – US 0.6 %

1.3.2 EVALUATION: PROCEDURES AND GLOBAL EVALUATION OUTCOME, REDRESS, STATISTICS (NO. OF EVALUATORS, GENDER, AREA, ETC.)

Under the AWP 2018, approved by the GB on 14 December 2017, the FCH2 JU published the H2020-JTI-FCH-2018-1 call for proposals on 16 January 2018 (Official Journal C014). In accordance with the H2020 rules (vade-mecum) on proposal submission and evaluation, an evaluation report, including all annexes (main list, reserve list, ineligible list, evaluation summary reports (ESRs), statistical information on proposals received, and experts' report, panel report and observer report) was submitted to the GB for approval. Of the 61 proposals received, 3 were withdrawn by the FCH 2 JU due to abusive submissions or proposals created to test the IT platform. The distribution of the remaining 58 proposals, according to pillar and call topic, is given below:

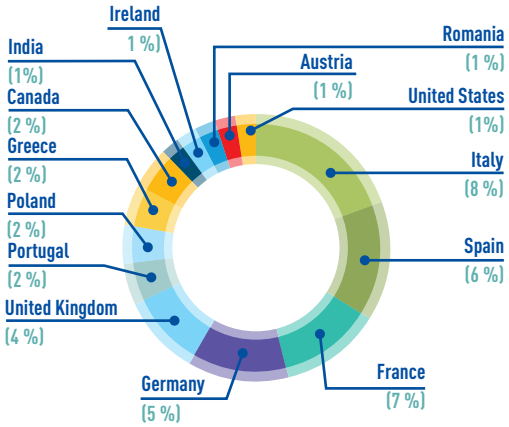
TABLE 1.3.2: NUMBER OF PROPOSALS EVALUATED

ACTIVITY AREA	ROW LABELS	TOPIC COUNT
Transport	FCH-01-1-2018	2
	FCH-01-2-2018	2
	FCH-01-3-2018	2
	FCH-01-4-2018	2
	FCH-01-5-2018	3
	FCH-01-6-2018	2
	FCH-01-7-2018	5
Energy	FCH-02-1-2018	5
	FCH-02-2-2018	1
	FCH-02-3-2018	2
	FCH-02-4-2018	3
	FCH-02-5-2018	4
	FCH-02-6-2018	3
	FCH-02-7-2018	3
	FCH-02-8-2018	5
Overarching	FCH-03-1-2018	1
Cross-cutting	FCH-04-1-2018	2
	FCH-04-2-2018	1
	FCH-04-3-2018	3
	FCH-04-4-2018	7
	Grand total	**58**

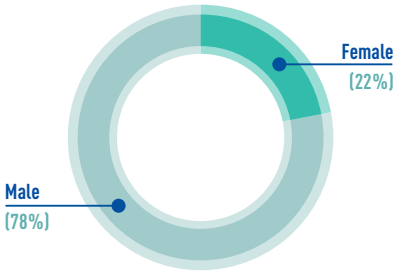
All evaluated proposals were eligible.

The 58 proposals included 434 participations. The proposals were evaluated by 45 independent experts (41 evaluators, 3 chairs and 1 observer), and 37 proposals (64 %) passed all the call thresholds. The figures below provide statistics on the 41 evaluators:

Graph 1.3.5: Breakdown of experts by country



Graph 1.3.6: Breakdown of experts by gender



The final ranking list for the call did not deviate from the experts' recommendations.

The distribution of retained proposals and budget per panel is provided in the table below:

TABLE 1.3.3: BREAKDOWN OF PROPOSALS PER PILLAR AND ACTIVITY

	PANEL	AVAILABLE BUDGET IN PANEL	NUMBER OF ELIGIBLE PROPOSALS RECEIVED	NUMBER OF PROPOSALS RETAINED (MAIN LISTS)	NUMBER OF PROPOSALS IN RESERVE LIST	PROPOSED BUDGET – MAIN LISTS
Transport	FCH-01-1-2018 + FCH-01-2-2018	EUR 17 000 000,00	4	2	1	EUR 16 999 978.75
	FCH-01-3-2018	EUR 2 700 000.00	2	1	1	EUR 2 853 958.75
	FCH-01-4-2018	EUR 4 000 000.00	2	1	1	EUR 3 995 305.00
	FCH-01-5-2018	EUR 4 000 000.00	3	1	2	EUR 4 493 025.00
	FCH-01-6-2018	EUR 3 000 000.00	2	1	1	EUR 2 962 681.25
	FCH-01-7-2018	EUR 2 750 000.00	5	1	2	EUR 2 749 613.75
Energy	FCH-02-1-2018 + FCH-02-2-2018 + FCH-02-3-2018	EUR 18 000 000.00	8	3	2	EUR 17 999 183.51
	FCH-02-4-2018	EUR 3 000 000.00	3	1	0	EUR 2 999 940.00
	FCH-02-5-2018	EUR 2 000 000.00	4	1	1	EUR 1 999 230.00
	FCH-02-6-2018	EUR 2 000 000.00	2	1	0	EUR 2 335 997.50
	FCH-02-7-2018	EUR 1 500 000.00	3	1	1	EUR 1 681 602.50
	FCH-02-8-2018	EUR 500 000.00	5	1	1	EUR 528 750.00
Overarching	FCH-03-1-2018	EUR 4 000 000.00	1	1	0	EUR 3 999 947.50
Cross-cutting	FCH-04-1-2018 + FCH-04-2-2018 + FCH-04-3-2018 + FCH-04-4-2018	EUR 8 750 000.00	14	3	5	EUR 6 010 925.00
	Grand total	**EUR 73 200 000.00**	**58**	**19**	**18**	**EUR 71 610 138.51**

After giving the applicants information on the outcome of the evaluation, no further requests were received for review (redress) which proves yet again the excellent quality of the evaluation process.

1.4 CALL FOR TENDERS

The FCH 2 JU has funded four studies through calls for tender.

On the basis of the AWP 2017 and AWP 2018, the FCH 2 JU has launched four operational procurements (open procedures) on the following topics:

1. Study on use of FCH in the railway environment

This study was an inter-institutional procurement procedure, tendered jointly by Shift2Rail Joint Undertaking (S2R JU) and the FCH 2 JU based on their respective AWP 2018. It was led by S2R JU.

The objective of the study was to identify and assess the business opportunities and technological barriers for the use of FCH as a means to further electrify the rail sectors by replacing remaining diesel solutions.

The study was contracted out on 29 May 2018 for a period of seven months and a budget of EUR 569 500. It included provisions for three reports on the implementation of each task, with a final comprehensive report delivered as a draft in December 2018.

2. FCH market and policy observatory

In spite of the potential and progress of fuel cells, as an efficient conversion technology, and hydrogen, as a clean energy carrier, there is considerable variability in the pattern and pace of pre-commercialisation and commercialisation across EU countries and regions, between technologies and application areas, and between different policy and investment frameworks. However, the data available is very limited at the EU and national level concerning the penetration of FCH technologies in the EU market and there is no coordinated methodology on how to monitor their market evolution. In most cases, this fragmented data is not publicly available.

The objective of this contract is to fill this gap by establishing an observatory with the aim of becoming a reference point for information about FCH technologies and applications. The observatory will gather data in the following areas: technology and markets; socio-economic; policy and regulation, codes and standards (RCS); and financial support and incentives.

The service contract was signed on 14 December 2018 for a period of 40 months and a budget of EUR 1 247 910. Several reports are expected, including an interim report, due in month 16, which will contain the first public version of the observatory and will be marked by a launch event, followed by two yearly analysis reports and one final implementation report at the end of the contract.

3. Concept for an HRS availability system

In order to provide a satisfactory HRS experience for FCEV users, in 2017, the FCH 2 JU contracted the services of a consortium of contractors to set up a concept/viable scenarios for developing a system for monitoring HRS availability in the EU. The aim of this system is to give access to reliable, up-to-date and standardised data on HRS status to FCEV users.

The contract tendered in 2017 and implemented until 2018 was the first part of a two-phase procurement implementation. The second phase builds on the results of the first study and its findings. The scope of the second phase is the implementation, improvement and update of the proof of concept delivered in the first study into a full-scale monitoring system that would cover at least all those public HRS servicing FCEV which are financially supported by the FCH 2 JU.

This work was contracted on 5 November 2018 for a period of 12 months and a budget of EUR 291 540. The study's final report, as well as an HRS availability platform, will be available in December 2019.

4. Study on future EU hydrogen scenarios, impacts and added value

The main objectives of the proposed study are twofold: (i) to build a convincing scenario for the large-scale introduction of hydrogen in the EU until 2050 and to quantify its impact; and (ii) to compare hydrogen with other alternative solutions to decarbonise specific applications and establish to what extent hydrogen is needed to achieve the EU's goals.

The service contract was signed on 23 April 2018 for a period of six months and a budget of EUR 200 000.

Developed with input from 17 leading European industrial actors, the study sets out a pathway for the large-scale deployment of FCH until 2050 and quantifies the associated socio-economic impacts. It concludes that hydrogen is an essential element in the energy transition and could account for 24 % of final energy demand and 5.4 million jobs by 2050. The final report[109] is available on the FCH website.

Three remaining calls for tenders indicated under Section H. Public Procurements of the AWP 2018, namely:

- Hydrogen for decarbonising heat
- European economic fuel cell bus by 2020
- FCH market potential in Central and Eastern Europe

have been transferred to the list of public procurements in support of operational activities to be carried out under AWP 2019.

Although the drafting of tender specifications for these studies was initiated during 2018, because of the modifications to energy and transport policy, on the one hand, and new developments in the sector, on the other hand, the scope of the three indicated calls for tenders was re-evaluated. During the GB meeting of 25 October 2018, it was decided that they would be re-scoped to address new realities and needs in the sector. As a result, they are included in the AWP 2019 as follows:

- Role of power-to-gas in contributing to Member States meeting their energy and climate targets
- European business cases for FCH trucks and technology development roadmap
- Project development assistance (PDA) for regions, in particular from Central and Eastern European countries.

1.5 DISSEMINATION AND INFORMATION OF PROJECT RESULTS

The FCH 2 JU has been part of the Horizon 2020 Dissemination and Exploitation Network (D&E-Net) (previously DiEPP) established by the EC's DG RTD under the H2020 Strategy for the common dissemination and exploitation of research and innovation data and results for the remaining period of 2018-2020. In 2018, the D&E-Net main working group launched six subgroups: (1) D&E practices across the R&I family and capacity building; (2) Data sharing and visualisation; (3) Activating multipliers and synergies; (4) Virtual market place and go-to-market tool; (5) Strengthening policy feedback; and (6) Exploitation and impact in Framework Programmes (FPs). FCH 2 JU has appointed representatives for each working group and has been following their activities closely while contributing to the periodical meetings.

Closely aligned with the knowledge management actions, the monitoring of FCH 2 JU project dissemination and exploitation activities continued during 2018. Despite the fact that the EC Common Exploitation Booster (CEB) and Common Dissemination Booster (CDB) was not active for most of 2018, 10 FCH 2 JU projects under the energy pillar requested the SSERR services where projects receive consultancy-type advice on exploitation aspects. The programme office informed the projects' consortia via a number of different communications means, such as events (Info Day, Coordinators' Day, Programme Review Days, etc.) about the importance of these services and tools for enhancing project dissemination and exploitation plans. Dissemination and exploitation of project results awareness started before signature of the grant agreement, during its preparation and is closely monitored throughout its duration.

Furthermore, the World Alliance for 1 000 Efficient Solutions initiative[110] is supported by the EC to facilitate procedures for the certification of EU-funded projects that demonstrate clean and affordable solutions to the world. At present, the World Alliance already counts 474 members which together combine more than 500 potential solutions, ranging from a wide variety of clean and energy-efficient solutions to applications for decarbonising the mobility sector. Solutions certified under the 1000 Solutions initiative will enjoy a number of benefits, such as greater visibility, access to a global network of companies and institutions, etc. To date, more than six FCH 2 JU projects have already been preselected (the list will be made public soon).

In addition, the FCH 2 JU started to participate in the pilot phase of Innovation Radar[111] and the exercise was conducted across 18 projects.

109 https://fch.europa.eu/news/hydrogen-roadmap-europe-sustainable-pathway-european-energy-transition

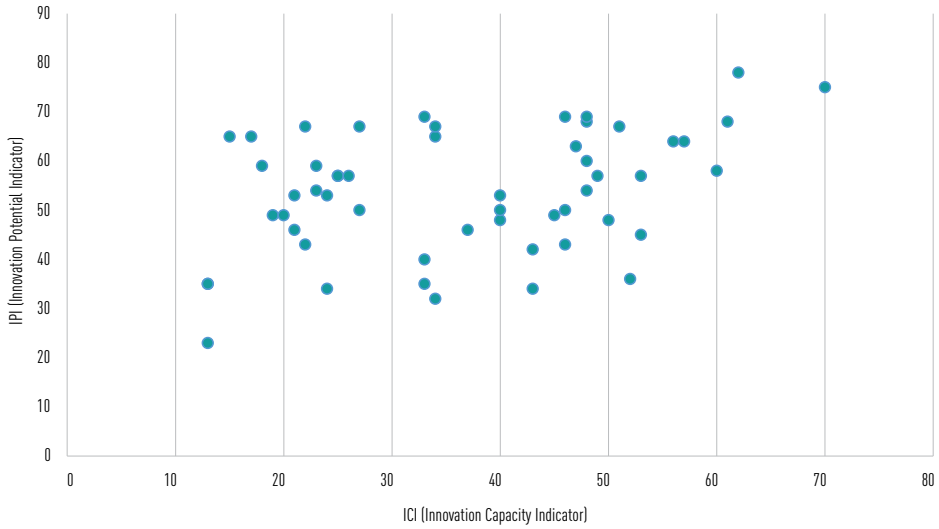
110 https://solarimpulse.com/

111 https://www.innoradar.eu/

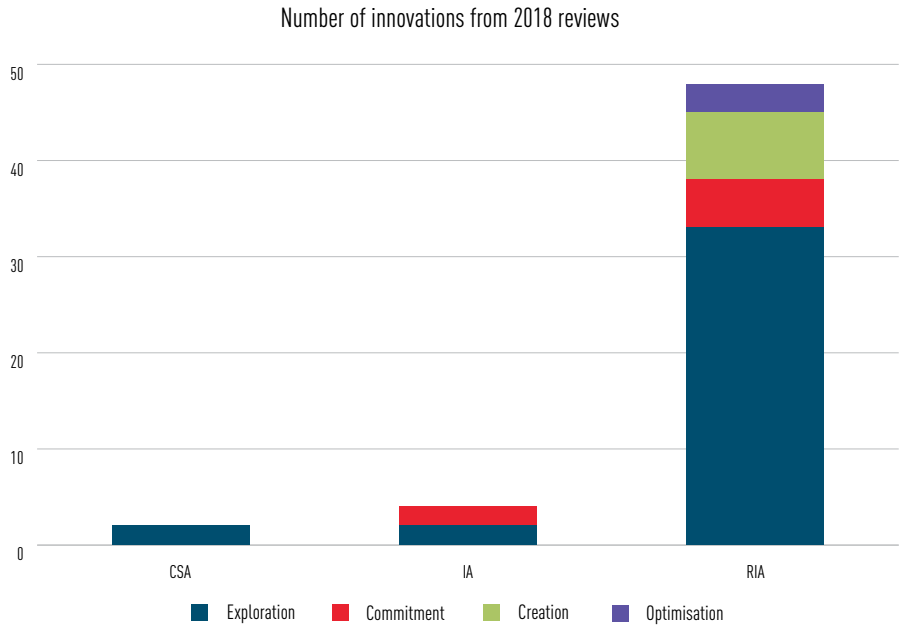
This initiative aims to identify high-potential innovations and the key innovators in H2020 projects. So far, the Innovation Radar pilot exercise has been conducted in project mid-term reviews where a dedicated expert is mandated to identify potential innovations and has to fill out a questionnaire with the aim of providing information in a structured manner. The purpose of the Innovation Radar exercise was not only to identify promising actors with the potential to grow, but also to stimulate and propel them to 'make it happen' faster and more efficiently.

With the help of the questionnaire, the Innovation Radar expert provided concrete recommendations on the innovation aspects of the project and for individual innovator organisations within the consortium. As the innovation radar exercise was linked to the mid-term review exercise, when applicable, these recommendations were also integrated into the formal review report.

Graph 1.5.1: Extract from the Innovation Radar dashboard indicating the identified innovations ranked in terms of Innovation Score and Innovator Score (0-100)



Graph 1.5.2: Innovations stemming from H2020 FCH2 JU projects that were reviewed in 2018 based on the Innovation Radar methodology



So far, based on the results of 18 projects, a total of 54 innovations have been recorded. These are displayed in the graph above and have been categorised based on the Innovation Radar methodology, between 'exploration', 'commitment', 'creation' and 'optimisation'. These categories are meant to span the path between the most basic TRLs of 'exploration' to the most advanced and closest to a potential product of 'optimisation'. A very positive result has also been the identification of at least 11 innovations that score above 50 points in the innovation potential indicator, making them ideal first candidates for follow-up actions for exploitation, proposals for financing, etc.

Through the information provided by this pilot, the FCH 2 JU has collected valuable feedback which is communicated during liaisons with DG RTD and DG CONNECT. This has been done in an effort to find out how the initiative can be further improved as well as exploring how the information collected can be further utilised by other EC services that support the commercial exploitation of research results (e.g. SSERR). Furthermore, the innovations/innovators identified will be supported for further exploitation of their results (e.g. pitching to possible investors, etc.).

Finally, the FCH 2 JU will monitor any FCH 2 JU project activity within these initiatives to provide dedicated assistance in either the exploitation or dissemination of results.

1.5.1 PROJECT INFORMATION ON THE FCH 2 JU WEBSITE

The FCH 2 JU website includes a dedicated page for each funded project (246 projects to date, covering calls 2008-2018) including information on dates, duration, funding, beneficiaries, call, topic and abstract. This information is continuously updated with changes resulting from the relevant amendments. Public project deliverables and publishable summaries can be found in the relevant Cordis links indicated on each project webpage. The information is searchable in dedicated query pages. Where relevant, additional communications (new projects signed) and dissemination activities (e.g. project achievements at mid-term or end-date) are 'pushed' in the form of news on the FCH 2 JU website, with links to the project pages.

1.5.2 PROGRAMME REVIEW DAYS

The 2017 PRD report, which was finalised and published on the FCH 2 JU website in December 2018[112], represents the outcome of the review performed by the JRC in 2017. The eighth edition of the PRD was held on 14-15 November 2018 at the EC's Charlemagne Building. The aim was to assess the programme's progress and achievements in relation to the targets set in the MAWP Addendum and the relevant AWPs, as well as in relation to the international state-of-the-art developments.

In 2018, an updated methodology was delivered by the JRC and adopted by the Programme Office (PO). The main developments were related to the alignment of the data collection exercise between TRUST and the relevant programme review questionnaires (in 2018, for the first time, questionnaires were delivered in the form of an online EU survey), as well as the use of TRUST platform by JRC in the context of the annual programme review exercise.

In addition, a total of 85 project posters were produced on a new, updated pre-designed template. Furthermore, an innovation in terms of project posters was demonstrated with a tailor-made interactive interface and dedicated smart screens displaying the digital project posters during the Programme Review Days.

Oral presentations were delivered by 29 projects and 4 tenders/studies, in 6 sessions/panels: 1) Trials and Deployment of Fuel Cell Applications – Transport; 2) Trials and Deployment of Fuel Cell Applications – Energy; 3) Support for Market Uptake (Day 1); 4) Next Generation of Products – Transport; 5) Next Generation of Products – Energy; and 6) Hydrogen for Sectoral Integration (Day 2). Each session opened with a presentation, including analysis of the projects' portfolios. The Scientific Committee as co-moderators and the audience were able to clarify various issues (in performing the review) during Q&A sessions.

Furthermore, in the context of supporting exploitation activities while bringing projects closer to the market, the FCH 2 JU together with DG RTD and the SSERR initiated a pilot brokerage event that culminated in the pitching of results by trained representatives of beneficiaries of four of FCH 2 JU projects during the PRD 2018 event. Graph 1.5.3 illustrates the feedback received in terms of the performance of pitchers (FCH 2 JU beneficiaries) during the Programme Review Days as well as the support of coaches within the context of the SSERR services in their preparation for the event (including webinars and bilateral training). It should be noted that three of the four solutions presented received more than three points, scoring well in the completeness and clarity of business proposition as well as in the overall quality of pitching.

112 https://www.fch.europa.eu/sites/default/files/FCH%20Report%202018_FINAL_Nov2018%20%28ID%204762408%29.pdf

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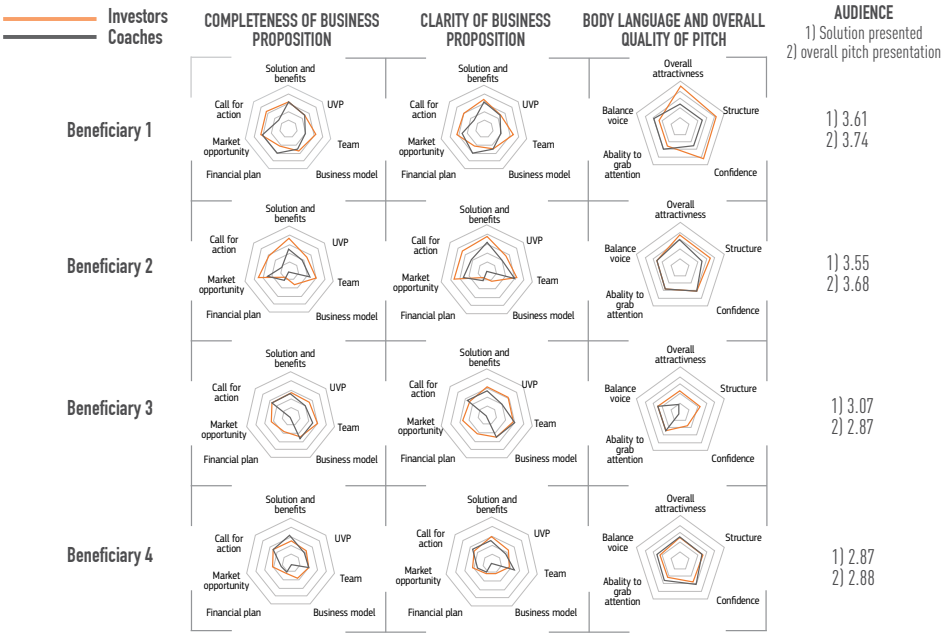
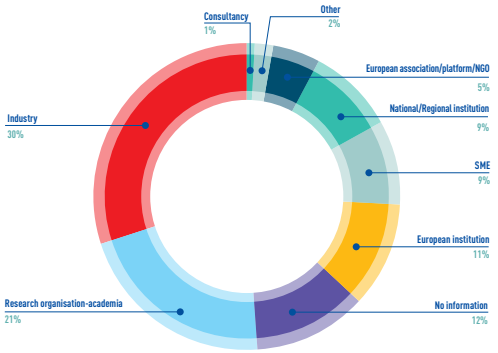
Graph 1.5.3: Feedback summary of brokerage event



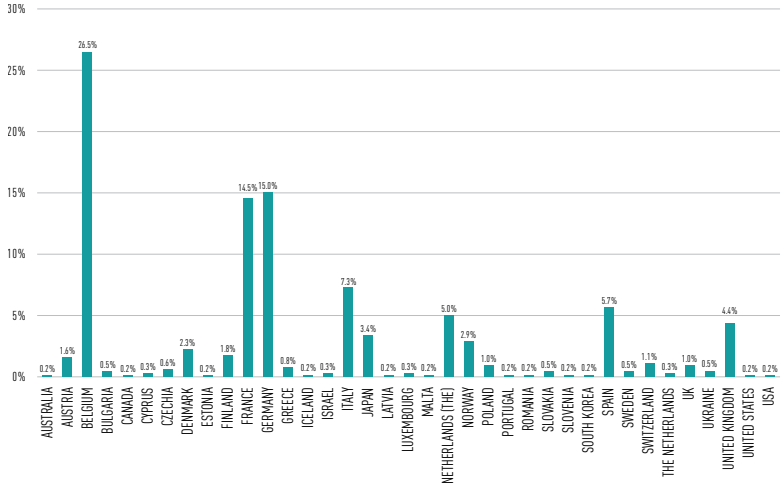
total of 493 registered participants attended both the PRD and the Stakeholder Forum. In addition, based on IP addresses, more than 470 web-streaming viewers followed the two-day PRD 2018 event.

Post-event activities, including a survey among participants, indicated that balanced participation was achieved by industry, research organisations and other EU and national/regional institutions (Graph 1.5.4). National representations also demonstrated satisfactory coverage across European countries (Graph 1.5.5). Participants were very satisfied with the agenda, the content of the presentations and invited speakers as well as the interaction opportunities during the event.

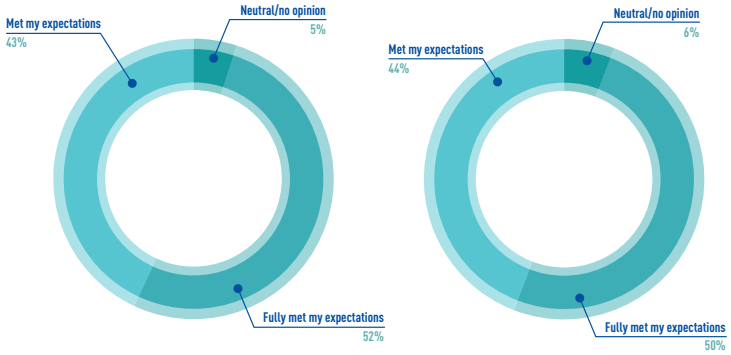
Graph 1.5.4: Participation by organisation in Programme Review Days and Stakeholder Forum



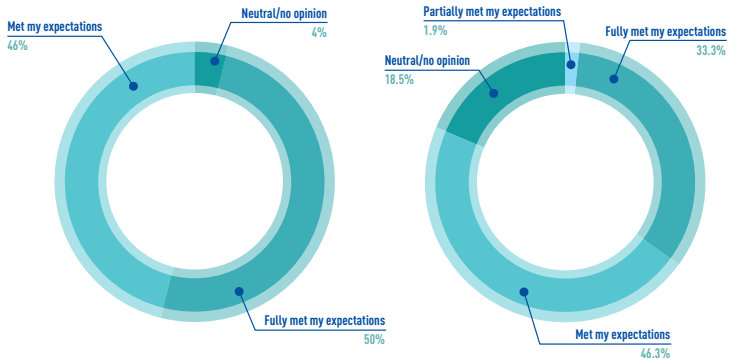
Graph 1.5.5: Participation by country in Programme Review Days and Stakeholder Forum



Graph 1.5.6: Level of satisfaction: agenda, quality of programme



Graph 1.5.7: Level of satisfaction: speakers invited, interaction opportunities



1.6 OPERATIONAL BUDGET EXECUTION

The total budget available in 2018 (after taking into account internal assigned revenues) reached EUR 85 504 157 in terms of commitment appropriations and EUR 126 526 307 in terms of payment appropriations.

In more detail:

FP7 budget

In 2018, 29 interim and mainly final periodic reports were assessed with a total amount of payments reaching EUR 21.4 million. The budget execution (in terms of payment appropriations) reached 79.6 % (73.8 % in 2017).

H2020 budget

There were 33 interim and 1 final payments in 2018. In addition, from H2020 operational payment appropriations there were 19 prefinancing payments (3 from call 2017 and 16 from call 2018), 11 payments for studies, 2 payments to the JRC, and payments to the experts on the European Hydrogen Safety Panel.

Budget execution in terms of payment appropriations reached 83.4 % (93.3 % in 2017). The lower execution rate compared to 2017 stems from delays in the grant agreement preparation for two major demo projects (WIND2HYRAIL and H2Haul). Therefore, their respective pre-financings (estimated at EUR 9.2 million) were not disbursed.

In terms of commitment appropriations, the execution rate reached 95.8 % (98.3 % in 2017). The lower rate, as compared to 2017, was due to the outcome of the call whereby one topic (hydrogen admixtures) was not covered and to the delay in the procurement plan (see Section 1.3).

For further details on the budget, see Section 2.3.

1.7 IN-KIND CONTRIBUTIONS

FP7

The FCH 2 JU founding regulation (Council Regulation 521/2008 as amended by Regulation 1183/2011) states that the operational costs of the FCH 2 JU shall be covered through the financial contribution of the European Union and through in-kind contributions from the legal entities participating in the activities.

Calculation of the level of in-kind contributions follows a methodology approved by the FCH 2 JU GB on 10 February 2012. Verification of these costs includes: i) *ex-ante* controls before validation of the cost claims submitted by the beneficiaries (either based on desk-review assessment by the PO and/or certificates on financial statements provided by independent auditors); and ii) *ex-post* audits after validation of the cost claims, carried out by independent auditors appointed by FCH 2 JU, in line with the FCH 2 JU *ex-post* audit strategy.

In addition, in accordance with the methodology, the aggregated level of in-kind contributions is assessed every year by an independent external auditor.

In 2018, KPMG carried out the assessment and confirmed the amount of the aggregated level of in-kind contributions certified by the FCH 2 JU Executive Director (cut-off date 31 December 2017).

The full publishable report can be found at: http://www.fch.europa.eu/page/annual-activity-reports

The 2018 audit assessment (cut-off date 31 December 2018) is carried out by KPMG in February 2019.

As of 31 December 2018, details of the aggregated level of in-kind contributions are as follows (in EUR):

TABLE 1.7.1: AGGREGATED LEVEL OF IN-KIND CONTRIBUTIONS

FP7 2018	ACCUMULATED VALIDATED IKC CONTRIBUTIONS AT 01/01/2018	VALIDATED IKC CONTRIBUTIONS IN YEAR 2018	IKC CONTRIBUTIONS RECEIVED BUT NOT VALIDATED AT 31/12/2018	IKC CONTRIBUTIONS ESTIMATED (PRO-RATA) AT 31/12/2018	IKC CONTRIBUTIONS ESTIMATED TO BE VALIDATED AS FROM 01/01/2019	FORECAST OF AGGREGATED LEVEL OF IN-KIND CONTRIBUTIONS
Industry grouping	253 683 166	25 072 914	1 242 167	21 643 862	12 891 121	314 533 230
Research grouping	124 622 304	16 634 986	330 564	6 040 794	4 997 571	152 626 219
TOTAL	**378 305 470**	**41 707 900**	**1 572 731**	**27 684 656**	**17 888 692**	**467 159 449**

In-kind contributions in H2020

The FCH 2 JU legal framework for in-kind contributions[113] is defined in Council Regulation 559/2014 of 6 May 2014 establishing the FCH 2 JU, in which Article 4 provides that:

'The Members of the FCH 2 Joint Undertaking other than the Union shall make or arrange for their constituent entities or their affiliated entities to make a total contribution of at least EUR 380 million over the period defined in Article 1.'

When assessing the level of contributions according to the above-mentioned article, the FCH 2 JU distinguishes between different types of contributions:

- Financial contributions
- In-kind contributions in operational activities (IKOP)
- In-kind contributions in additional activities (IKAA)

113 This legal framework was complemented by a methodology for IKOP and a methodology for IKAA agreed by the FCH 2 JU GB on 18 November 2015 and 9 December 2016, respectively.

Thus, the overall minimum threshold of EUR 380 million for the H2020 programme refers to the sum of all three types of contributions.

In 2017, FCH 2 JU members other than the EU were able to demonstrate that the **threshold of EUR 380 million had been surpassed,** mainly thanks to the high level of IKAA certifications received for the first two reporting periods.

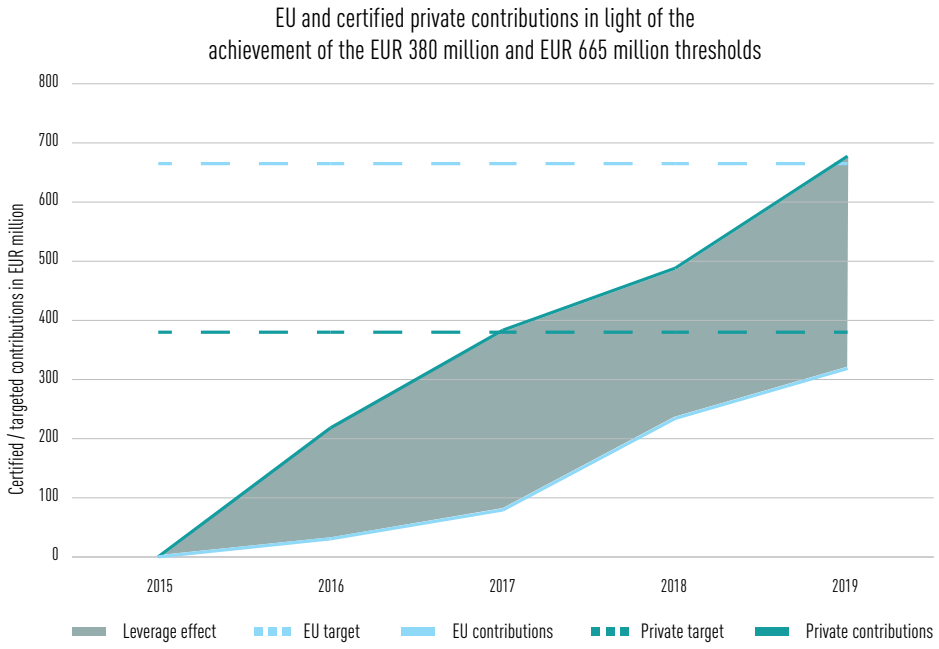
In 2018, an additional **EUR 2.34 million in financial contributions**, an extra **certified EUR 1.19 million of in-kind contributions from projects** and **newly certified EUR 104.09 million from additional activities** were added to give an **overall figure of EUR 491.77** million of certified contributions from private members.

The table and graph below provide an overview of members' contributions under FCH 2 JU:

TABLE 1.7.2: FINANCIAL CONTRIBUTIONS AND CERTIFIED AMOUNTS AS AT 31 DECEMBER 2018

Financial contributions to FCH 2 JU administrative costs	IN EUR MILLION
Industry	3.14
Research	0.51
TOTAL	**3.65**
Indirect actions – in-kind contributions 'IKOP'	
Total certified IKOP as of 31 December 2018[114]	1.82
Additional activities – certified 'IKAA'	
Certified IKAA (2014-2016) as of 31 December 2017	382.21
Newly certified IKAA as of 31 December 2018	104.09
Total certified IKAA (2014–2017) as of 31 December 2018	**486.30**
Total: Financial + IKOP + IKAA as of 31 December 2018	**491.77**

GRAPH 1.7.1: EU AND CERTIFIED PRIVATE CONTRIBUTIONS AS OF 31 DECEMBER 2018



114 Based on the first finalised H2020 *ex-post* audits and in line with IKOP methodology

In-kind contributions in operational activities (IKOP)

IKOP are costs incurred in implementing indirect actions minus the contribution of the FCH 2 JU and any other EU contribution to those costs (Statutes, Article 13.3.b).

To be considered as IKOP, these costs must be incurred by members of Hydrogen Europe or Hydrogen Europe Research or their affiliates participating in FCH 2 JU indirect actions.

The regulation provides that IKOP should be valued according to members' usual accounting practices and applicable national and international accounting standards (Regulation, Art 4.4).

The Council Regulation allows the members to base their declaration of IKOP on the basis of their "total costs" (according to their usual accounting practices) which may be slightly higher than their "eligible costs" (according to H2020 rules). On a proposal from the Industry and Research Groupings, the GB decided to limit IKOP to eligible costs for cost-efficiency and simplification reasons.

As a result, the IKOP in H2020 projects for FCH 2 JU are limited to the amount of eligible costs as per H2020 rules, less the EU contribution.

Calculation of the level of in-kind contributions is based on the methodology endorsed by the GB on 18 November 2015. *Ex-ante* controls for the IKOP under H2020 follow the harmonised practice in line with the common strategy of the rest of the RTD family, with the aim of simplifying and easing the controls performed when the payment is approved.

Ex-post certification of IKOP is provided by the *ex-ante* certificate of financial statements (CFS) which, compared to the FP7 programme, are only applicable for the final project period where the amount of FCH contribution to direct costs is higher than EUR 325 000.

Validation of the amount of IKOP is provided at Executive Director level, upon receipt of the CFS certificate and/or based on the result of the *ex-post* audits.

The amount of IKOP reflected in the FCH 2 JU accounts is based on all signed running projects as of 31 December 2018, considering mainly the estimated costs (mostly pro rata), as well as cost claims which were received but had not been validated at the cut-off date.

As of 31 December 2018, the estimated in-kind contributions for the 90 projects signed for the H2020 programme (2014, 2015, 2016, 2017 and 2018 calls) were as follows (in EUR):

TABLE 1.7.3: OVERVIEW OF IN-KIND CONTRIBUTIONS IN OPERATIONAL ACTIVITIES (IKOP)

H2020 IN 2018	ACCUMULATED VALIDATED IKOP AT 01/01/2018	VALIDATED IKOP FOR 2018	IKOP RECEIVED BUT NOT VALIDATED AT 31/12/2018	IKOP ESTIMATE (PRO-RATA) AT 31/12/2018	IKOP ESTIMATE TO BE VALIDATED	FORECAST OF AGGREGATED LEVEL OF IKOP
Industry grouping	627 961	1 197 171	141 163	26 747 950	92 301 626	121 015 871
Research grouping				1 483	3 018	4 501
TOTAL	**627 961**	**1 197 171**	**141 163**	**26 749 433**	**92 304 644**	**121 020 372**

Most of the IKOPs were not certified, as this will happen later during the H2020 programme, at the final payment of the projects when the CFS are due.

In-kind contributions in additional activities (IKAA)

According to the FCH 2 JU regulation, additional activities (AA) are defined as activities carried out by members of Hydrogen Europe and Hydrogen Europe Research and their affiliates contributing to the FCH 2 JU programme's objectives but undertaken outside of its work plan, which are not funded by the EU or the JU.

The regulation provides that determination of the costs taken into account for the valuation of the in-kind contributions shall be in accordance with the usual cost accounting practices of the entities concerned, the applicable accounting standards of the country where the entity is established, and the applicable international accounting standards and international financial reporting standards (Article 4.4).

The FCH 2 JU regulation establishes a minimum level of IKAA at EUR 285 million over the period defined in Article 1 of the regulation.

In 2018, the following important activities took place (in chronological order):

1. (Preliminary) Reporting of the values of the IKAA contributions for 2017 by Hydrogen Europe and Hydrogen Europe Research Members as of 31 January 2018

As per the Council Regulation, members of the FCH 2 JU other than the EU shall report each year by 31 January to the FCH 2 JU GB on the value of the contributions in additional activities made in each of the previous financial years.

In accordance with the regulation, the 2017 IKAA preliminary report was submitted on 31 January 2018 to the FCH 2 JU GB for information. An estimated IKAA of EUR 143.32 million were reported as achieved compared to the initial 2017 IKAA plan of EUR 176.29 million[115] adopted by the FCH 2 JU GB on 21 December 2016.

A trend to report lower amounts in the preliminary reporting is normal since the initial plan is created based on long-term estimates of possible activities which are adjusted at the time of reporting.

2. IKAA certifications for the period 2017 and additional certification of activities covered in the 2016 IKAA Plan[116]

The 2017 IKAA report on certified figures was inherently derived from the 2017 IKAA Plan which encapsulated planned activities declared by the members at the beginning of the period. To ensure strict continuity and compliance with the adopted Plan, no new activities (for the 2017 reporting period) compared to the adopted 2017 IKAA Plan, were included in that report.

The final 2017 IKAA report included **EUR 104.09 million of certified activities from the IKAA 2017 Plan**. Differences between the planned and realised figures were mainly due to projects postponed or not executed to the full extent as initially planned.

In addition, a few members provided certificates for the period 2016 for additional activities not previously certified, totalling EUR 24.29 million, resulting in **an increase in the total certified IKAA for the period 2014–2017 to EUR 486.30 million**.

A full publicly available version of the final 2017 IKAA report can be found on the FCH 2 JU website at:
http://www.fch.europa.eu/page/in-kind-additional-activities

3. The public version of the IKAA 2018 Plan was prepared by Hydrogen Europe and Hydrogen Europe Research and was published on the FCH 2 JU website

A total of 68 Hydrogen Europe and Hydrogen Europe Research members submitted their investment plans for the period 1 January to 31 December 2018 to the FCH 2 JU GB in December 2017, including 191 different additional activities for a **total of EUR 250 million** (subject to certification in 2019).

With these submissions for 2018, the members have provided **the highest amount of estimated annual IKAA since the beginning of the H2020 programme**, demonstrating a strong and growing commitment to the partnership's goals, far beyond the minimum requirements established in the Council Regulation.

The public version of the report can be found on the FCH 2 JU website: https://fch.europa.eu/page/in-kind-additional-activities

4. Establishing the IKAA 2019 Plan

The next Additional Activities Plan, covering the period 1 January 2019 to 31 December 2019 and amounting to EUR 198.49 million, was established by the members in December 2018. At the time of preparing the current annual activity report, this plan was in the process of being adopted by the FCH 2 JU GB.

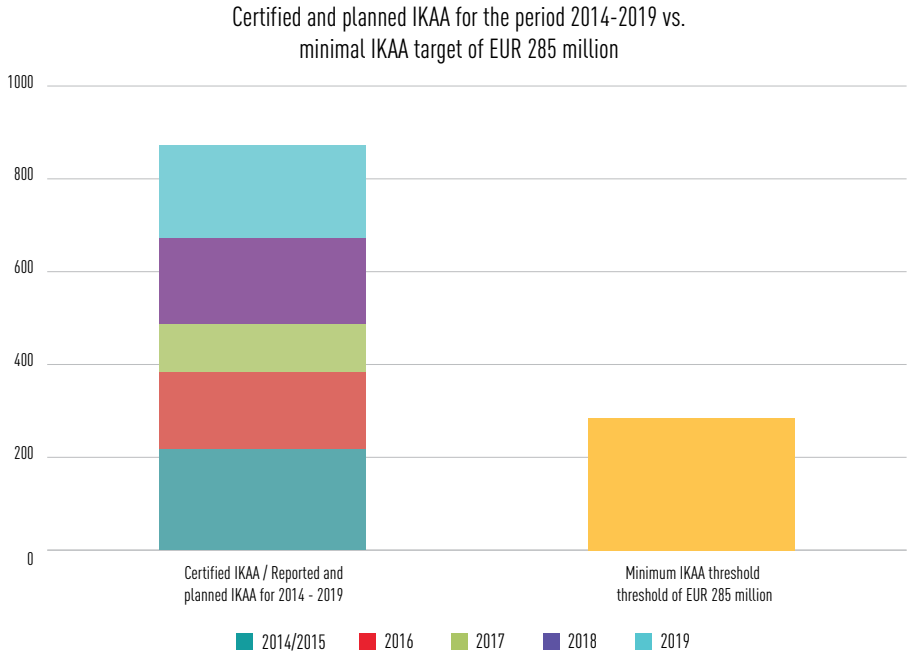
115 The 2017 IKAA Plan's final figure of EUR 176.29 million did not include contributions of EUR 2.16 million from 16 small members which did not reach a cumulative certification threshold of EUR 325 000 introduced in 2016 as a major simplification, relieving small members, in particular, of additional administrative burdens whilst ensuring coverage of over 98 % of the total amount of the planned activities with obligation to certify.

116 The planning, reporting and certification process of IKAA in 2017 followed a formal FCH 2 JU IKAA methodology, describing a robust control process to ensure the planned, reported and certified IKAA figures are reasonable (the methodology was agreed by the FCH 2 JU GB on 9 December 2016).

5. General overview of additional activities

This section provides an overview of the cumulative amount of IKAA:

- Certified IKAA for the period 2014-2017 (based on the certificates received and validated by 31 December 2017, totalling EUR 486.30 million);
- Planned IKAA for the period 2018-2019 (based on 2018 IKAA Preliminary Report submitted to FCH 2 JU GB by private members on 31 January 2019 for the sum of EUR 186.63 million, and the 2019 IKAA Plan[117] submitted by private members in December 2018 for the sum of EUR 198.49 million).



The FCH 2 JU believes that the scope of investments captured in the IKAA plans 2018-2019, together with data already certified for 2014-2017, is a clear testimony of the FCH sector members' strong commitment, the continued progress of these technologies towards the market, and the strong leverage of FCH 2 JU investment. The Joint Undertaking believes that these investments in additional activities embody a robust contribution towards achieving joint objectives set in the FCH 2 JU regulation.

117 IKAA 2019 Plan will be submitted to FCH 2 JU GB for adoption early in 2019, followed by a certification process in 2020.

02
SUPPORT TO OPERATIONS

2.1 COMMUNICATION ACTIVITIES

2.2.1 COMMUNICATION OBJECTIVES 2018

Throughout 2018, the communication activities focused on presenting the results and successes of the FCH 2 JU as a public-private partnership and demonstrating the concrete advantages of the technology and its potential to address the decarbonisation targets, in line with the objectives set by the MAWP/AWPs.

The main themes included:

- Most advanced FCH technologies and their applications: transport (buses, cars and related infrastructure) and energy (electrolysers and micro CHP) with a focus on FCH 2 JU projects' results and success stories;

- Successful collaboration between the EU, research and industry is leading to breakthroughs for European research and innovation. Through a partnership with the industry and research sectors, the FCH 2 JU pools Europe's resources to tackle some of its the biggest challenges, supports competitiveness to deliver high-quality jobs, and encourages greater private investment in research and innovation.

Target audiences

The FCH 2 JU continued to reach out to key actors from the **European institutions**, to keep them informed about the Joint Undertaking's activities and results and to involve them in relevant events. This translated into the organisation of working meetings and joint events with the European Commission and the European Parliament. The FCH 2 JU communication team also continued to work closely with its counterparts from the other Joint Undertakings, in view of communicating joint initiatives and studies and exchanging experience, and with the EC's CRIG (communication correspondents' group) of the Research and Innovation Family Communication Units.

The communication activities also targeted **potential (new) participants** in the FCH 2 JU's calls for proposals, through up-to-date, relevant information provided on online channels and during various events, such as info days.

Furthermore, **new audiences** in various European countries (such as Bulgaria, Ireland, Slovakia and Ukraine) were targeted in order to enhance knowledge of the FCH 2 JU as a funding initiative and of the technology itself, and to attract interest from public authorities and potential applicants.

The participation of a **wider public** was stimulated throughout various events and campaigns (Sofia hydrogen summit and roadshow, a public information campaign carried out in Brussels, FCH 2 JU Awards) and by intensifying activity on social media channels.

2.2.1. PUBLIC OUTREACH ACTIVITIES – EVENTS

Launch of REFHYNE project

REFHYNE, the FCH 2 JU's new project was launched on 18 January 2018 during an event held in Cologne, Germany. The consortium will build a new hydrogen electrolysis plant, the largest of its kind in the world, at the Rheinland refinery in Germany. With a capacity of 10 MW, the hydrogen will be used primarily for the processing and upgrading of products at the refinery's Wesseling site. REFHYNE will assist in testing the PEM technology on a large industrial scale, making its introduction feasible in other industry plants, as well as having the potential to be a step towards the future of refining.

FCH 2 JU info day

Following the publication of its yearly call for proposals, the FCH 2 JU held an info day on 26 January 2018 to provide further insight into the call to potential participants. The 2018 edition was successful and special efforts were made to attract a larger and diversified audience. The event was organised in the White Atrium premises in Brussels, and included a brokerage session, as per the previous year. The event was broadcast live and around 100 participants joined on-site.

Hannover Messe

Hannover Messe is one of the world's largest trade fairs and also provides the venue for Europe's largest hydrogen, fuel cells and battery exhibition. From 23 to 27 April, the 2018 edition featured 60 exhibitors from 20 countries plus an outside Ride + Drive area where visitors were able to test, among others, the latest models of FC electric vehicles. Traditionally, numerous FCH 2 JU beneficiaries attend the fair as exhibitors and speakers in the public and technical forums throughout the week. The FCH 2 JU participated with a dedicated slot entitled 'FCH 2 JU supporting European SMEs', accelerating technological breakthroughs. Three SME beneficiaries of FCH 2 JU funding – Elcogen, HyET and Hydrogenious – discussed the topic alongside the FCH 2 JU Executive Director Bart Biebuyck. He underlined that SMEs are the backbone of the FCH sector in Europe, having the invaluable ability to innovate and adapt quickly. 25 % of FCH 2 JU funding has been awarded to SMEs, exceeding the Horizon 2020 target of 20 %. Following the podium discussion, the FCH 2 JU hosted a networking cocktail, which was an opportunity for participants in the hydrogen fuel cell exhibit to meet and discuss their ideas and latest developments in the field.

TEN-T Days in Slovenia

FCH 2 JU participated in the 9th edition of the TEN-T Days, held in Ljubljana, Slovenia between 25 and 27 April 2018. This year's edition focused on how to contribute to smart, sustainable and safe mobility, relying on the trans-European transport network and investments in transport connectivity.

The event, organised by the EC and hosted by the Transport Commissioner Violeta Bulc, welcomed 26 ministers and over 2 200 participants from all over Europe. This edition was attended by high-level public authorities and stakeholders, including the Vice-President of the EC for the Energy Union Maroš Šefčovič, Commissioner for Budget and Human Resources Günther Oettinger and Commissioner for Regional Policy Corina Crețu.

Central and Easter European Hydrogen Tour and Hydrogen Summit in Sofia

The Hydrogen Summit was organised in Sofia, Bulgaria on 28 May 2018 by the FCH 2 JU during the Bulgarian Presidency of the Council of the EU and marked the Joint Undertaking's 10th anniversary.

The Summit was attended by a number of Bulgarian politicians, including MEP Peter Kouroumbashev, Minister of Education Krasimir Valchev, and Deputy Transport Minister Anguel Popov, who said that hydrogen-fuelled vehicles represented the future of cars.

FCH electric vehicles were available to test drive in front of the National Palace of Culture during side events supported by the Ministry of Transport, Information Technology and Communications, the Ministry of Education and Science, the Bulgarian Academy of Sciences and the Sofia Municipality, among others.

A hydrogen charging station was also demonstrated, and staff from the Technocrati Educational Centre involved children and adults in on-site experiments to share a glimpse of the exciting future offered by renewable energy.

As well as the family day on 27 May and the Hydrogen Summit in Sofia, two additional events took place in Budapest (Hungary) and Timişoara (Romania). Supported by local hydrogen associations and policymakers, these events sparked a lot of interest among both the participants and the general public. The FCH 2 JU's two FCH cars were on display and available to test drive. In Budapest, István Lepsényi, state secretary from the Ministry for National Economy, and László Palkovics, state secretary from the Ministry of Human Capacities met with Bart Biebuyck to discuss the current situation and future plans for FCH technologies in Hungary.

Timişoara's Mayor's office welcomed the FCH 2 JU's second event in Central and Eastern Europe. Representatives of the FCH 2 JU were pleased to meet Mayor Nicolae Robu and introduce the Joint Undertaking's work. Two Members of the European Parliament took the opportunity to test drive the FC cars, gaining a new appreciation of the many advantages of FC technologies.

EUSEW 2018

A clear message emerged from the FCH 2 JU-hosted session on FCH greening European industry: FCH are essential to the future of European industry. Speaking at the session, Bart Biebuyck, Executive Director, underlined the role of hydrogen in Europe's clean energy future, by enabling the integration of renewables and sectors. Industry remains the most difficult sector to decarbonise, but thanks to the efforts of the FCH 2 JU and the industry grouping Hydrogen Europe, big industries are now discovering the potential of hydrogen.

Furthermore, on 6 June, the FCH 2 JU PACE project hosted an EUSEW 2018 side event 'Powered by people', showing how fuel cell micro-cogeneration has the power to put citizens at the centre of the energy transition. PACE has demonstrated that the technology is mature, and there is now a solid track record showing that FC technology is reliable and efficient.

HyBalance project inaugurated an advanced facility for the production of green hydrogen

On 3 September 2018, the HyBalance project inaugurated an advanced facility for the production of renewable hydrogen in Hobro, Denmark. The hydrogen is produced from water electrolysis, enabling the storage of renewable electricity from wind turbines while, at the same time, balancing the electricity grid. The hydrogen produced will be used for greening the industry and transportation sectors.

Launch of the Hydrogen Initiative and presentation of the H2FUTURE project

One of this year's highlights was the presentation of the H2FUTURE project in the context of the informal meeting of EU energy ministers on 17 and 18 September in Linz, Austria. On this occasion, the Hydrogen Initiative was launched under the Austrian Presidency of the Council of the European Union.

The 8th General Assembly of FCH 2 JU's Regions and Cities Initiative

More than 70 representatives from local and regional authorities, industry and policymakers attended the 8th General Assembly of the Regions and Cities Initiative, which took place on 9 October 2018 at the FCH 2 JU's premises in Brussels.

Hydrogen Mobility Roundtable

On 10 October 2018, the EU flagship H2ME hydrogen project hosted the Hydrogen Mobility Roundtable in partnership with the FCH 2 JU and Hydrogen Europe. At the event, representatives from the initiative met with local municipalities and regional government representatives from across Europe to discuss real-world experiences, best practice and proven business models for the increased roll-out of FCEV vehicles and cross-border hydrogen refuelling infrastructure.

Coordinators Day 2018

Following its call for proposals 2018, the FCH 2 JU held a Coordinators Day on 13 September 2018. Coordinators of successful projects were invited for a day of sessions covering details on the preparation and signature of a grant agreement. The FCH 2 JU PO also presented topics such as audit, knowledge management, dissemination and communication.

Opening of the 50th hydrogen refuelling station in Germany

The 50th hydrogen refuelling station in Germany was inaugurated on Friday, 7 September, in Potsdam, in the framework of the H2 MOBILITY project. This represents an important milestone in the expansion of the H_2 infrastructure in Germany; the event attracted high-level national policymakers as well as media interest.

Hydrogen powering-up the material handling sector in Europe – HyLIFT-EUROPE project event

The largest deployment of hydrogen-powered fuel cell materials handling vehicles in Europe took place on 22 November 2018 in the framework of the HyLIFT-EUROPE project. Carrefour, one of Europe's largest retailers, inaugurated the operation of a fleet of 137 hydrogen-powered fuel cell materials handling vehicles in its warehouse which is located in France, at Vendin-Le-Vieil.

The FCH 2 JU Awards

2018 marked FCH 2 JU's 10th anniversary and the partnership's successful journey as a catalyser of projects that have enabled Europe to take a leading role in FCH technology. On 15 November, FCH 2 JU rewarded its top projects for innovation excellence by hosting an awards ceremony in Brussels – a first for the FCH 2 JU.

All the nominated projects demonstrate the benefits of collaboration between research, industry and policymakers in European partnership to deliver innovation and accelerate the transition to a greener world. The winners were chosen by public vote, which mobilised the European FCH community around the 26 nominees – 13 for each category (success stories and innovation).

- The Innovation Prize went to the Cell3Ditor project (partners IREC, 3DCERAM, PROM and DTU, leading the innovation).
- The Success Story Prize went to the 'Power to the People' story (involving the projects ene.field and PACE).
- The H2FUTURE project, a European flagship project for the generation of green hydrogen from electricity from renewable energy sources was honoured with a special mention for communications excellence in raising the visibility of FCH technology for low-carbon manufacturing during the Austrian Presidency of the Council of the European Union (2018).

'Tonight's winners demonstrate the added value of the EU's investment in cutting-edge, innovating, hydrogen technology,' said Signe Ratso, EC Deputy Director-General for Research and Innovation, who presented the Innovation Award.

Mirela Atanasiu, Head of the FCH-JU Operations and Communications Unit concluded: 'The winners represent the best of hydrogen cell fuel potential. In truth, all the success stories and top three nominees deserve this award. The level of achievement is outstanding.'

Stakeholder Forum 2018

The FCH 2 JU Stakeholder Forum took place on 16 November. Around 400 participants gathered in Brussels to take stock of the latest achievements within the sector, while addressing the challenges of building the hydrogen infrastructure across the EU. Using hydrogen for renewables integration and sector coupling, and the economic potential of hydrogen in the global context were among the main topics discussed.

Stakeholders present at the event agreed that the partnership is delivering and must continue its work, building on the successes of the past 10 years.

'Hydrogen is a key technology for achieving Europe's climate and energy goals. Its potential benefits for the environment, consumers and European economy can power the transition of Europe's energy sector towards a green future,' said Maroš Šefčovič, Vice-President of the European Commission for Energy Union, speaking at the FCH 2 JU Stakeholder Forum.

Addressing the FCH 2 JU Stakeholder Forum of energy and climate experts from industry, research, EU institutions, NGOs and local and regional authorities, the Vice-President underlined the need to combine different technological solutions to reach Europe's ambitious goals. 'We know that no single technology can solve our energy and climate challenges. In 10 years of existence, the FCH 2 JU partnership has showed the potential of the technology; we need now to ensure public acceptance, for this we need to continue promoting, telling the story of our success', highlighted Signe Ratso, Deputy Director-General for DG Research and Innovation.

EC Director-General for Climate Action, Mauro Petriccione, concluded:

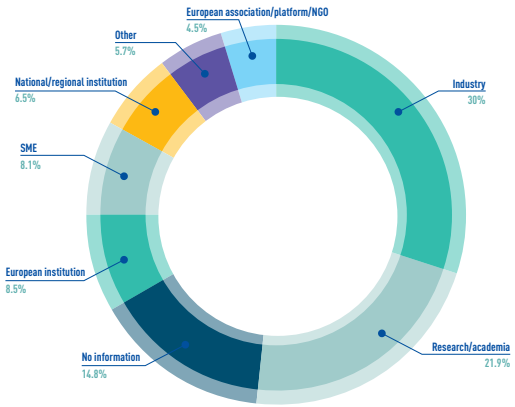
'The development and testing of breakthrough technologies is a prerequisite for successfully combating climate change while having a prosperous and modern economy. Deep decarbonisation of many sectors would require that new low-carbon solutions are widely deployed in the coming years. Green hydrogen can help decarbonise many end-use sectors. Initiatives such as the Fuel Cells and Hydrogen Joint Undertaking and the other public-private partnerships have an important role to play to successfully support the development of such technologies.'

Taking into account the recommendation of the GB, the FCH 2 JU broadened the target audience for the Stakeholder Forum 2018 by inviting representatives of the civil society (NGOs) and other international associations and organisations.

SF2018 Survey:

- 87 % of the participants were satisfied with the quality of the programme
- 83 % of the participants were satisfied with the awards ceremony

Graph 2.1: Participation by category (for both Programme Review Days and Stakeholder Forum)



It also encouraged interactive participation through live Q&A sessions via Sli.do. Slido was used in four other events organised throughout 2018, leading to better engagement from the audience.

Graph 2.2: Statistics from Slido on interactive participation

Participants at your events asked **103 questions**

Those questions were **liked 150 times**

Your participants **voted 28 212 times**

Here's how you used our features at your events:

Questions	Polls	Ideas
40%	80%	0%

ZEB 2018

The FCH 2 JU attended the Zero Emission Bus Conference 2018 (ZEB), held in Cologne on 27 and 28 November 2018. The event, organised by Hydrogen Europe and Element Energy, under the umbrella of the JIVE and JIVE-2 projects, saw a record presence of around 370 participants from all over Europe, including policymakers, bus operators and industry experts to drive forward the realisation of zero-emission public transport for Europe. FCH 2 JU Executive Director, Bart Biebuyck was one of the keynote speakers, and the FCH 2 JU presented a stand with information on the programme – with a focus on transport applications.

2.1.3 PUBLIC OUTREACH ACTIVITIES – CAMPAIGNS

For the FCH 2 JU, 2018 marked a milestone in terms of outreach and brand recognition. Several initiatives targeted the broader public and the world of associations present both in Brussels and in other EU countries. Alongside the awareness tour in Central and Eastern Europe, the FCH 2 JU decided to raise its profile via a pilot awareness campaign targeting the wider public in Brussels. The campaign included posters and banners displayed in the city subway and public transport network and a promotional video. It also featured social media content.

Through this campaign, the FCH reached out to a wider public, beyond the hydrogen industry and research community, with simple messages focusing on H_2 applications (H_2 for green energy and green transport) and the Joint Undertaking (a partnership dedicated to clean energy and transport in Europe).

We aimed to raise awareness among a mixed, English-speaking audience comprising EU policymakers and bureaucrats from different areas of EU activity, experts and representatives of the EU Member States (and beyond) travelling to/in Brussels, young people and influencers.

Posters in key metro stations

Bus banners

The campaign made a good impact during its two-week duration; in particular, the posters and bus banners reached out over 800 000 viewers, while the video (which only ran for one week), reached out to about 40 000 viewers. The traffic on the FCH 2 JU website increased as well due to the QR code placed on the posters, which demonstrates the impact of the pilot campaign.

Graph 2.3: Statistics on public awareness campaign in November 2018

Network 2019	JCD 2m² horizontaux	JCD Digital Schuman
	14 DAYS	7 DAYS
Performances on target group	TOT 18-54 BXL19	TOT 18-54 BXL19
Universe (target audience)	627 878	627 878
VRP	137 %	63 %
VAContacts (of target)	861 485	395 429
VAReach (Contacts-Unique)	354 955	145 367
VACover (% Contacts-Unique)	56.5 %	23.2 %
VAFrequency	2.4	2.7

ROTS	Realistic opportunity to see
VAC	Visibility Adjusted Contacts
VRP	Visible Rating point
VAFrequency	Number of times seen
VAReach	Unique viewers (abs. – min 1 x seen)
VACovers%	Unique viewers in % of target group

Campaigns and events driving website and social media traffic

It is interesting to note that the traffic registered on the website has more than doubled compared to the previous period. The campaign and the promotion of various events resulted in new users targeting the website and looking at the webpage 'who we are'.

Social media participation increased significantly in 2018 – for example, the number of twitter followers increased from 1 600 in July 2018 to 2 241 followers in January (a rise of about 40 %).

Activity on LinkedIn also increased, with 1 265 current followers.

2.1.4 COMMUNICATION ON PROJECT RESULTS

Success stories

Following the 10-year anniversary of the FCH 2 JU, the communication efforts focused on the enormous progress that FCH technology has made in Europe through the results of various FCH 2 JU projects. The **success stories** presented in the new Success Stories brochure illustrate the continuous learning approach exemplified by the FCH 2 JU projects, from creating low-carbon and sustainable solutions, enabling market entry for new products, developing 'next-generation' products based on previous research, to opening new markets for European expertise in FCH technology. Each of the stories shows how collaboration between research, industry and policymakers in a European partnership delivers the best innovation and accelerates the transition to a greener world.

Collaboration with Horizon Magazine included the publication of articles on the production of green hydrogen and the development the hydrogen economy, featuring FCH 2 JU-funded projects REFHYNE, H2FUTURE, HyBalance, and BIG HIT, HYDROSOL-PLANT and BioRobur, respectively.

Collaboration with **Cordis** included the publication of success stories on the projects BIG HIT, COPERNIC and CISTEM. Further collaboration foresees the publication of success stories about the projects HySEA (focusing on the international cooperation with China) and AutoStack-CORE. We aim to increase the number of projects presented by means of success stories and results pack.

The FCH 2 JU also contributed to the new portfolio of videos of research and innovation projects supported by the EU through Horizon 2020 and previous Framework Programmes, with the following project videos:

- The SOFC value chain in Europe: the qSOFC, INNOSOFC and DEMOSOFC projects;
- DEMOSOFC in numbers

Synergies with project communications

Overall, the FCH 2 JU's **communication with project partners** aimed to increase synergies and amplify the outcome of the communication activities.

For example, a joint communication task force was set up in July 2018 to align activities with the bus and car demonstration projects. The following events benefited from joint communication and inputs from the FCH 2 JU:

- 1 Sept. – HRS opening in Frechen in Germany (SWARM project)
- 7 Sept. – HRS opening in Potsdam in Germany (H2ME project)
- 26 Sept. – HRS opening in Swindon, UK (H2ME project)
- 10 Oct. – Policymakers' roundtables in Brussels, Belgium (H2ME project)
- 17 Oct. – SWARM project final event in Coventry in the UK
- 26-27 Nov. – Demonstration site for FC electric buses in Sanremo, Italy (High V.LO-City project).

2.1.5 PUBLICATIONS

Throughout 2018, the FCH 2 JU produced several publications which were made available both online on the FCH 2 JU website and through the distribution of printed copies at various events. It promoted the publications through its newsletter and social media channels.

Success Stories Brochure – Each of the stories shows how collaboration between research, industry and policymakers in a European partnership delivers the best innovation and accelerates the transition to a greener world.

Study on Fuel Cells and Hydrogen for Green Energy in European Cities and Regions – Fuel cells and hydrogen are a viable solution for European regions and cities to reduce their emissions and realise their green energy transition, according to a new FCH 2 JU study.

Study on Strategies for joint procurement of fuel cell buses – The study analyses the funding and financing of FC bus deployment to make them a mainstream zero-emission choice for public transport providers in cities and regions across Europe. Within this study, 90 different European cities and regions were helped to understand the business case for FC bus deployment and across these locations.

FCH 2 JU brochure – This gives a general overview of the latest achievements of the FCH 2 JU and funded projects' success stories.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THE BEST THINKERS ON ENERGY
Premium Analysis Newsletter Categories... Post an article/event

Hydrogen is heading up the European policy agenda
September 18, 2018 by Clare Taylor

Hydrogen's momentum is building, as European ministers consider approving a new 'Hydrogen initiative' this week that aims to "maximise the great potential of sustainable hydrogen technology." With funding from the EU's Fuel Cells and Hydrogen Joint Undertaking, a consortium of industrial heavyweights in the H2FUTURE project is already ramping up production of hydrogen from renewable sources. But, as the International Renewable Energy Agency notes in a new report, for hydrogen to really take off would require broad political support.

2.1.6 MEDIA

Several opportunities were followed up during 2018, illustrating increased media interest in topics covering green, sustainable energy and transport.

Media coverage

Earned media

- In the green transition all industries must pull together: EURACTIV – 17 September 2018
- Profile: The Fuel Cells and Hydrogen Joint Undertaking (FCH 2 JU): Gas for Energy – 13 August 2018
- A green future: the Fuel Cells and Hydrogen Joint Undertaking Forum: SciTech Europa – 16 November 2018
- EU Energy Commissioner expects more money for fuel cells in Horizon...: Science Business – 16 November 2018
- Europe's future: fuel cell and hydrogen energy technologies: SciTech Europa – 8 November 2018
- Fuel-Cell Technology Gaining Momentum in EU : WardsAuto – 15 October
- Hydrogen is heading up the European policy agenda: Energy Post – 18 September

Media partnerships

- FCH technology supporting energy transition for cities and regions: Journal Général de l'Europe – October 2018

2.1.7 GDPR – COMPLIANT COMMUNICATION

In preparation for compliance with the General Data Protection Regulation (which entered in force in October 2018) the communications team updated the existing contacts and subscribers lists and carried out the necessary modifications on the website, in line with the new privacy laws.

2.2 LEGAL AND FINANCIAL FRAMEWORK

During 2018, the following procedures were drafted or updated and adopted:

- **Updated IAS Mission Charter**

The IAS updated its Mission Charter to reflect changes in the IIA International Standards for the Professional Practice of Internal Auditing; the revision introduces the following changes: (i) it is more focused on considerations of risks and risk management in the provision of the assurance and consulting services of the IAS; (ii) for certain types of engagement, the revised charter provides for the presentation of an audit conclusion instead of an audit opinion; (iii) the IAS will adhere to principles, rather than to guidance or standards as stipulated in mandatory elements of the 2017 version of the International Practices Framework (IPPF) promulgated by the Institute of Internal Auditors.

The revised Mission Charter was adopted by the FCH 2 JU GB on 15 March 2018.

- **New Internal Control Framework (ICF)**

The FCH 2 JU is entrusted with implementing the EU budget and thus should ensure a proper management and control mechanism in accordance with Article 32 of the Financial Regulation and provide a level of assurance from its systems at least equivalent to that of the European Commission. Following the adoption by the European Commission on 19 April 2017 of a revised Internal Control Framework (ICF), the FCH 2 JU GB adopted the revised FCH 2 JU ICF on 16 August 2018. It is designed to provide reasonable assurance regarding the achievement of five objectives set in Article 32(2) of the Financial Regulation:

– Effectiveness, efficiency and economy of operations

– Reliability of reporting

– Safeguarding of assets and information

– Prevention, detection, correction and follow-up of fraud and irregularities

– Adequate management of the risks relating to the legality and regularity of the underlying transactions, taking into account the multiannual character of programmes as well as the nature of the payments concerned.

- **Adoption of the 'FCH 2 JU Internal Procedure for the Annual Programme Review'**

Since 2011, the FCH 2 JU Programme Office (FCH 2 JU PO) has organised a yearly review of its programme, hereby referred to as the 'Programme Review'. Within this exercise, an event is also organised including projects, posters and presentations, hereby referred to as the 'Programme Review Days'.

The Programme Review is carried out by the JRC and the EC's DG Energy, Transport and Climate.

The updated procedure was adopted by the Executive Director on 10 September 2018 and takes into account the lessons learnt from cooperation on the basis of the projects funded by the programme and is carried out with the JRC and recommendations from the EC's IAS.

- **Adoption of the updated 'FCH 2 JU Internal Procedure for Review/Assessment of Periodic Reports'**

The fourth update of the procedure (which relates to FP7 projects), adopted on 28 November 2018, takes into account the migration of the FCH 2 JU to the ARES document management and registration system, as well as the multiple options that ARES provides for simplified procedures and paperless workflows. It also aligns the process with the one in use for H2020 reports.

- **Policy on learning and development**

On 26 January 2018, the FCH 2 JU GB adopted the FCH 2 JU Framework for Learning and Development. In accordance with this framework, a new learning and development policy was adopted by the Executive Director on 20 December 2018, setting out the main principles and identifying the learning and development priorities for the PO in the upcoming years.

- **Other rules and procedures**

Other rules were adopted, mainly implementing rules on staff regulations and a newcomer package (see Section 2.6).

2.3 BUDGETARY AND FINANCIAL MANAGEMENT

2.3.1 BUDGET

The FCH 2 JU budget consists of the revenue and expenditure side. On the expenditure side, the budget is divided into three titles:

- Title 1 covers staff expenditure, such as salaries, training, costs associated with the recruitment procedure, missions, medical expenses and representational costs;

- Title 2 covers the cost associated with the functioning of the FCH 2 JU, such as renting of premises, IT needs, expenses related to external communication, expert fees and cost of *ex-post* audits;

- Title 3 covers operational activities of FCH 2 JU for both FP7 and H2020 programmes.

Compared to 2017, the 2018 commitment appropriations decreased by 33 % whereas payment appropriations decreased by 36 %. Regarding payment appropriations, it should be noted that the pre-financings for two calls (call 2016 and partly 2017) were paid in 2017 (instead of just one in 2018) which explains the drop in 2018 payment appropriations.

There were two amendments and four budget transfers in 2018. The first amendment, which was adopted by the FCH 2 JU GB on 4 April 2018, introduced administrative and operational commitments and payments carried over from 2017. The second amendment was adopted by the FCH 2 JU GB on 20 December 2018 following the fall in operational payment appropriations as accepted in the context of the EC's global transfer procedure.

An overview of the initial budget, the amendments and transfers is presented below:

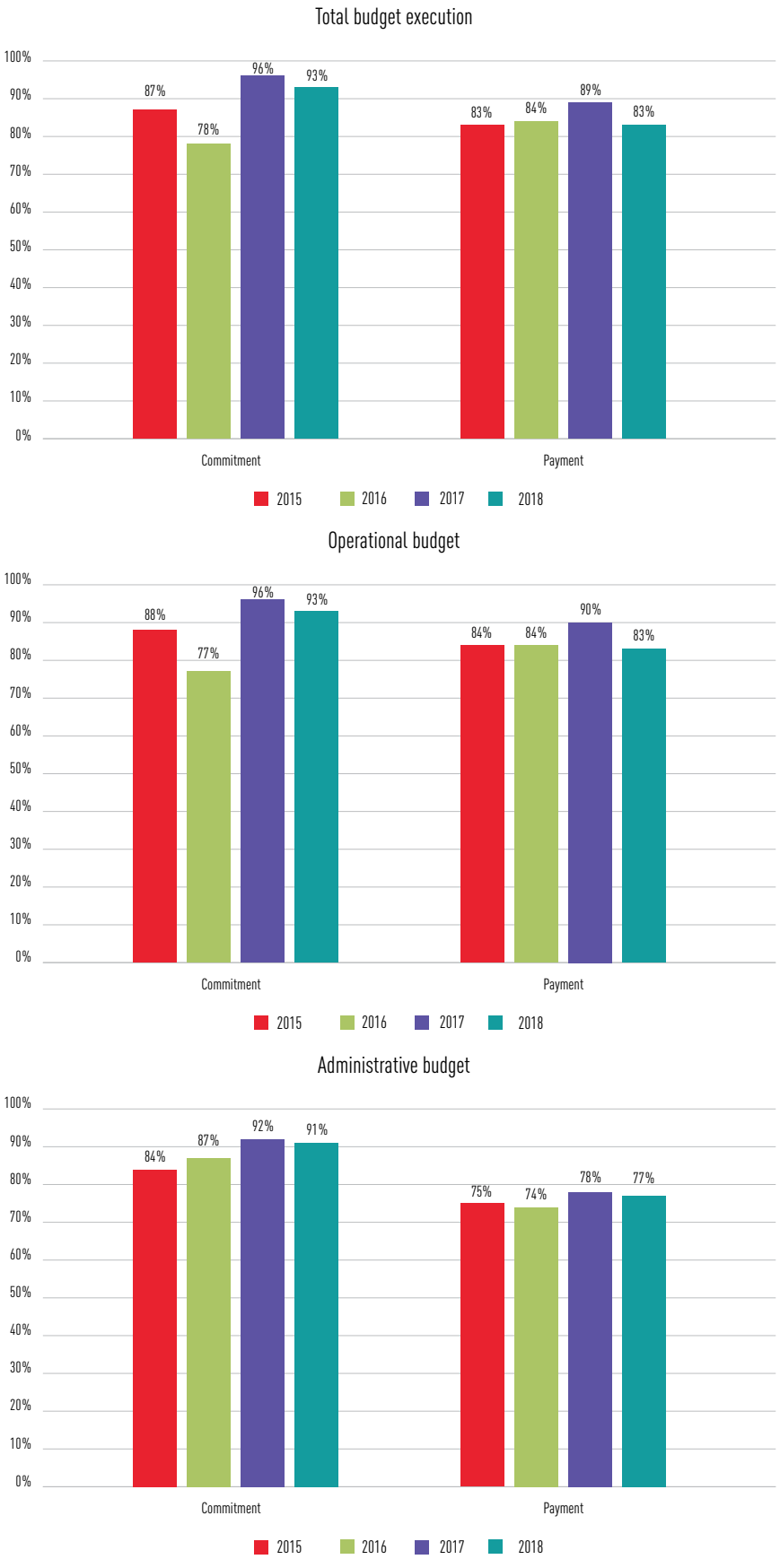
TABLE 2.3.1: 2018 BUDGET EVOLUTION

BUDGET 2018 (EUR)								
	VOTED BUDGET		AMENDMENTS		TRANSFERS		FINAL BUDGET	
	CA	PA	CA	PA	CA	PA	CA	PA
Revenue								
EU operational FP7		25 686.390		-10 100.000			0	15 586,390
EU operational H2020	75 099.696	95 296.147		-13 200.000			75 099.696	82 096.147
EU administrative	2 341.924	2 341.924	-1	-1			2 341.923	2 341.923
Hydrogen Europe	2 014.054	2 014.054	0	0			2 014.054	2 014.054
Hydrogen Europe Research	327 869	327 869	0	0			327 869	327 869
Reactivations from previous years	2 625.097	778 053	840 500	21 126.854			3 465,597	21 904.908
JTI revenues						2,255,017	2 255,017	2 255.017
Total revenue	**82 408.640**	**126 444.437**	**840 499**	**-2 173.147**	**0**	**2 255.017**	**85 504.157**	**126 526.307**
Expenditure								
Title 1	3 582.300	3 582.300	-11 000	95 120	-10 000	673	3 561.973	3 668.093
Title 2	1 879.600	1 879.600	211 000	904 997	10 000	11 902	2 112.502	2 806.499
Title 3 – FP7		25 686.390	367 891	-446 543		1 668.887	2 036.778	26 908.734
Title 3 – H2020	76 946.740	95 296.147	272 609	-2 726.720		573 554	77 792.903	93 142.981
Total expenditure	**82 408.640**	**126 444.437**	**840 499**	**-2 173.147**	**0**	**2 255.017**	**85 504.157**	**126 526.307**

2.3.2 BUDGET EXECUTION

In 2018, FCH achieved the second highest budget execution since 2015 in terms of commitment appropriations. However, the payment utilisation rate dropped by 6 percentage points compared to 2017, mainly due to the non-allocation of two major pre-financing payments, totalling EUR 9.2 million and related to two grant agreements (Wind2Hyrail and H2Haul) for which the preparation was delayed at the request of the consortium following complex issues still under discussion at year end.

Graph 2.3.1: Budget execution



The execution rates for the operational budget reached 93 % and 91 % for commitments and payments, respectively, as shown in graph 2.3.1. Administrative commitments and payments also showed the second highest rate since 2015.

More details regarding the budget execution:

Revenues

FCH 2 JU revenue for 2018:

TABLE 2.3.2: IMPLEMENTATION OF REVENUES

REVENUES (IN EUR)		
Heading	**Income appropriation (budgeted)**	**Cashed in 2018**
Operational expenditure, EU	97 682 537	97 682 537
Administrative expenditure, EU	2 341 923	2 341 923
Administrative expenditure, IG	2 014 054	2 014 054
Administrative expenditure, RG	327 869	327 869
Recoveries	2 255 017	2 255 017
Reactivation of appropriations	21 904 908	N/A
TOTAL	**126 526 308**	**104 621 400**

Expenditure

TABLE 2.3.3: IMPLEMENTATION OF EXPENDITURE

Title Chapter Article Item	**Heading**	**Commitment**				**Payment**			
		Commitment appropriations (CA) (1)	Commitments (2)	Non-used appropriations (3)=(1)-(2)	%committed (4)=(2)/(1)	Payment appropriations (PA) (5)	Payments (6)	Non-used payment appropriations (7)=(5)-(6)	%paid (8)=(6)/(5)
1	STAFF EXPENDITURE								
1 1 0 0	Staff costs	3 326 623	3 031 153	295 470	91.1 %	3 382 811	2 936 862	445 950	86.8 %
1 2 0 0	Expenditure related to recruitment	46 400	18 102	28 298	39.0 %	48 400	19 839	28 561	41.0 %
1 3 0 0	Mission expenses	138 350	137 700	650	99.5 %	169 596	155 380	14 216	91.6 %
1 4 0 0	Sociomedical infrastructure	45 000	38 533	6 467	85.6 %	59 036	46 837	12 199	79.3 %
1 5 0 0	Entertainment and representation expenses	5 600	3 568	2 032	63.7 %	8 249	4 989	3 260	60.5 %
TOTAL TITLE 1		3 561 973	3 229 056	332 917	90.7 %	3 668 093	3 163 907	504 186	86.3 %
2	INFRASTRUCTURE								
2 0 0 0	Rentals	354 917	325 060	29 858	91.6 %	375 352	300 704	74 648	80.1 %
2 1 0 0	IT costs operational	360 923	328 482	32 442	91.0 %	463 718	206 340	257 378	44.5 %
2 2 0 0	Movable property and associated costs office equipment	13 000	12 593	407	96.9 %	13 000	12 593	407	96.9 %
2 3 0 0	Current administrative expenditure	7 000	5 328	1 672	76.1 %	7 529	4 635	2 893	61.6 %
2 4 0 0	Correspondence, postage and tele-communications	12 000	10 650	1 350	88.8%	20 738	9 271	11 466	44.7%

Title Chapter Article Item	Heading	Commitment				Payment			
		Commitment appropriations (CA) (1)	Commitments (2)	Non-used appropriations (3)=(1)-(2)	%committed (4)=(2)/(1)	Payment appropriations (PA) (5)	Payments (6)	Non-used payment appropriations (7)=(5)-(6)	%paid (8)=(6)/(5)
2 5 0 0	Meetings in general	94 662	76 895	17 767	81.2 %	109 098	77 656	31 442	71.2 %
2 6 0 0	Communication costs	527 136	445 620	81 515	84.5 %	861 182	528 358	332 823	61.4 %
2 7 0 0	Service contracts	372 000	371 993	7	100.0%	515 917	336 885	179 032	65.3 %
2 8 0 0	Expert contracts and meetings	370 864	338 499	32 365	91.3 %	439 966	357 517	82 449	81.3 %
TOTAL TITLE 2		2 112 502	1 915 120	197 383	90.7 %	2 806 499	1 833 960	972 539	65.4 %
TOTAL TITLE 1+2		5 674 476	5 144 175	530 300	90.7 %	6 474 592	4 997 867	1 476 725	77.2 %
3	OPERATIONAL EXPENDITURE								
3 0 0 1	FP7	2 036 778	86 953	1 949 825	4.3 %	26 908 734	21 430 496	5 478 239	79.6 %
3 0 0 2	H2020	77 792 903	74 545 919	3 246 984	95.8 %	93 142 981	78 639 310	14 503 671	84.4 %
TOTAL TITLE 3		79 829 681	74 632 872	5 196 809	93.5 %	120 051 715	100 069 805	19 981 910	83.4 %
TOTAL		**85 504 157**	**79 777 047**	**5 727 109**	**93.3 %**	**126 526 307**	**105 067.67**	**21 458 635**	**83.0 %**

Administrative expenditure

The FCH 2 JU's administrative costs recorded the second highest rate of use in FCH 2 history (91 %). Unused appropriations coming from the 2018 budget total EUR 530 300 and together with the unused appropriations coming from previous years[118], amounting to EUR 132 080, will be reactivated in the 2020 budget.

Unused commitment appropriations have come mainly from staff costs due to the fact that two positions remained vacant for some time: one position was filled as of May (contrary to the assumption that it would be filled as of January) and the other became vacant in March and was filled in June. Departures of interim staff also added to the unused appropriations. In other cost categories, 85 % of the budget for communication was used as the scope for certain PR activities was reduced due to the contractor's inability to offer the services the FCH requested.

Operational expenditure

As regards the **H2020 operational costs** (call, studies, JRC and European Hydrogen Safety Panel), the commitment execution rate reached 95.8 %. The total unused appropriations are the result of not covering one topic from call 2018 (hydrogen admixtures), delays in the procurement plan whereby only two studies (from the five included in CA 2018) were contracted, as well as revenues from the recovery of pre-financing from a terminated project – these revenues were not committed. The largest part of these unused appropriations have already been reactivated in 2019 budget whereas the balance (EUR 263 606) will be reactivated either in 2019 or in 2020 according to needs.

The execution rate for H2020 payments (84.4 %) was lower than 2017 as two demo projects from call 2018 did not conclude the grant agreement preparation phase before 31 December 2018; consequently, pre-financing of EUR 9.2 million stayed in the FCH 2 accounts. The unused payment appropriations (EUR 10.5 million) will be re-entered in the 2019 and 2020 budgets according to payment needs.

As regards **FP7 operational costs,** the execution rate on the payment appropriations reached 79.6 %, which is an improvement on the 2017 performance. The unused payment appropriations of EUR 5 478 239 are due to delays in the submission of periodic reports and underspending and will be re-entered in the 2019 and 2020 budgets according to payment needs.

Overview of programme implementation

The following tables provide an overview of FP7 and H2020 implementation:

118 Coming from decommitments made in 2018.

TABLE 2.3.4: IMPLEMENTATION OF FP7 PROGRAMME

FP7 (IN EUR)			
Type	**Execution until 31.12.2018**	**Subsequent years**	**Total**
Commitments (operational costs)	450 851 384		450 851 384
Payments (operational costs)	409 508 173	18 081 522	427 589 695
Cumulative execution (operational costs)	**90.8 %**	**94.8 %**	**94.8 %**
Commitments (administrative costs)	30 658 610		30 658 610
Payments (administrative costs)	30 658 610		30 658 610
Cumulative execution (administrative costs)	**100.0 %**	**100.0 %**	**100.0 %**
Overall FP7 execution	**91.4 %**	95.2 %	**95.2 %**

As regards **operational costs**:

For **FP7**, the execution rate reached 90.8 %. The commitments under operational costs refer to individual commitments for grants and studies. In total, there were 155 grant commitments and 13 operational commitments referring to procurement activities. Until 31 December 2018, from a total of 155 grant agreements signed, 1 project was cancelled, final payments were made for 143 projects, and 11 projects remain open. The amount shown after 2019 refers to the interim and final payments for these 11 projects. It should be noted that the execution rate on the closed projects reached 93 %.

TABLE 2.3.5: IMPLEMENTATION OF H2020 PROGRAMME

H2020 (IN EUR)			
Type	**Execution until 31.12.2018**	**Subsequent years**	**Total**
Commitments (operational costs)	455 916 038	190 083 962	646 000 000
Payments (operational costs)	301 187 079	344 812 921	646 000 000
Cumulative execution (operational costs)	**66.1 %**	**100.0 %**	**100.0 %**
Commitments (administrative costs)	6 343 012	31 656 988	38 000 000
Payments (administrative costs)	5 528 667	32 471 333	38 000 000
Cumulative execution (administrative costs)	**87.2 %**	**100.0 %**	**100.0 %**
Overall H2020 execution	**66.4 %**	**100.0 %**	**100.0 %**

For **H2020**, the amount committed until the end of 2018 refers to the 92 individual commitments for H2020 projects, 15 studies contracted, 1 commitment for the European Hydrogen Safety Panel and 3 commitments for the annual work of the JRC.

As regards the **administrative costs**, an amount of EUR 814 345.28 was committed in 2017 and 2018[119] but not paid (as services are ongoing and/or invoices pending); therefore, this will be carried forward to meet remaining obligations.

Amendments signed in 2018

Besides assessing the periodic reports, FCH financial management also includes the processing of project amendments.

In 2018, the Executive Director signed 7 FP7 and 26 H2020 amendments.

119 2017 open commitments carried forward to 2019 amount to EUR 31 163.19 whereas 2018 commitments carried over to 2019 total EUR 783 182.09.

2.3.3 TIME TO PAY

Operational payments

In 2018, 63 FP7 and H2020 reports (interim and final) were assessed (72 in 2017). The overall Time To Pay (TTP) for FP7 and H2020 combined reached 70 days (68 days in 2017). The gross TTP (including any suspensions due to requests for clarifications and amendments) reached 127 days which is an improvement of nearly 40 % compared to the 2017 figures.

In more detail:

FP7

29 reports were assessed in 2018 (55 in 2017), of which 23 were final and 6 interim.

The average TTP of these reports reached 64 days (68 days in 2017). The gross TTP (164 days) was further improved by 17 % compared to 2017 as the suspension time was lower.

H2020

The average Time To Grant (TTG) for the 17 signed projects from call 2018 reached 229 days, which is a further improvement of nearly 2 % compared to the TTG for call 2017.

In 2018, 33 interims and 1 final report were assessed with an average TTP standing at 76 days (64 in 2017). The gross time to assess reached 96 days, 4 % lower than 2017.

Administrative payments

The average TTP for administrative payments (invoices from suppliers of goods, service providers and cost claims from experts/staff) reached 18.2 (16.7 in 2017). The number of late payments (5.2 %) was slightly higher than in 2017 (3.8 %) but is still the second-best performance over the last five years. The majority of late administrative payments were reimbursements to mission performers. At the beginning of 2018, a new electronic tool for monitoring mission orders and reimbursements was introduced and there was an adaptation period during which most of these late payments occurred.

2018 marked the year with the highest number of administrative payments (924) surpassing by more than 10 % the second highest year (2015 with 837).

2.4 PROCUREMENT AND CONTRACTS

The tender and contract management has been simplified as far as possible by following the inter-institutional procurement procedures launched by the EC, and using the resulting multi-annual Framework Contracts. FCH 2 JU also cooperates with other Joint Undertakings in tendering needs in order to minimise the administrative effort. These Framework Contracts have been concluded mainly in the field of IT services and interim staff provision.

As in previous years, most of FCH 2 JU's contracting was carried out under existing multi-annual Framework Contracts, except for operational procurement activities (see procurement studies under Section 1.4 Call for tenders). In terms of volume, procurement of studies and the managed IT services were the most significant procedures launched.

The table below gives an overview of the contracts awarded in 2018, including the procedure used in each case and the name of the contractor(s). Only those contracts with a value exceeding EUR 15 000 are listed below:

TABLE 2.4.1: CONTRACTS AWARDED IN 2018 (> EUR 15 000)

TYPE OF CONTRACT	CONTRACT TITLE	REFERENCE TO FRAMEWORK CONTRACT	SELECTION PROCEDURE (IF APPLICABLE FOR CONTRACT AWARDS)	NAME OF CONTRACTOR	AMOUNT (IN EUR)
Framework Contract	Managed IT services	FCH/Contract/204	Open procedure	Real Dolmen N.V.	2 400 000.00
Direct service contract	Study on fuel cells and hydrogen market and policy observatory	FCH/Contract 216	Open procedure	E4Tech (UK) Ltd.	1 247 910.00
Direct service contract	Study on use of fuel cell hydrogen in railway environment	S2R.18.OP.01	Open procedure	Roland Berger GmbH	300 000.00
Specific contract	Study on metering	FCH/contract 196		Air Liquide Advanced Technologies SA	295 000.00
Direct service contract	Study on HRS availability system II	FCH/OP/Contract 214	Open procedure	Spilett new technologies GmbH	291 540.00
Direct service contract	Study on EU hydrogen roadmap, impacts and added value	FCH/Contract/203	Open procedure	McKinsey and Company Inc.	200 000.00
Framework Contract	PR relations, media planning	FCH/Contract/205	Negotiated procedure for middle-value contract	PRACSIS sprl	143 000.00
Specific contract	Event organisation (SF/PRD 2018)	PO/2016-05/A2		Teamwork	116 051.25
Specific contract	FP7 audits (11th batch)	IMI.2017.OP.2015		Lubbock Fine	75 600.00
Specific contract	Managed IT services	IMI.2014.FWC.043		Realdolmen SA	60 890.62
Specific contract	Audits of annual accounts	BUDG15/PO/03		PKF Littlejohn	56 000.00
Direct contract for supplies	Mobile HRS supply	FCH/Contract 208	Negotiated procedure for middle-value contract	Air Liquide Advanced Technologies	44 000.00
Specific contract	PR services	FCH / Contract / 205		PRACSIS sprl	26 800.00
Specific contract	IT services (Testa-ng)	DI/07600		T-Systems International GmbH	18 342.72

2.5 IT AND LOGISTICS

The year 2018 was driven by the new ICT procurement procedure for IT managed services. FCH 2 JU also supported the change of provider for hosting the infrastructure shared by the JUs using cloud technology Infrastructure as a Service (IaaS), and the handover of the telephony services to new providers under EC Framework Contracts. The year was also marked by the adoption of ARES (the EC's records management tool) for the automation of FCH's administrative processes.

Support to FCH core business

As in previous years, FCH staff were assured adequate access to the complete set of EC applications for grant management, with an improved monitoring system of access rights, in line with prior audit recommendations. The role of the Single Point of Contact (SPOC) was further extended with the routing functionality to deal with workload and blocking situations in workflows. Close contacts were maintained with the CSC to ensure the successful implementation of the H2020 call 2018. New functionalities were introduced, including:

- The workflows for Audit Report Implementation (AURI), Finalisation (FINA), amendment (AMEND) and GA Termination – EU Services Initiated (GTEU) already in use and/or available for the FCH 2 JU were adapted to the business practices and proper allocation of actors for the various steps;
- The Project Monitoring (PMON) workflow was released in February;
- The Reinforced Monitoring report in BAM/EYES was made available in April;
- Audit Process In-Housed (AUPI), Audit Process Outsourced (AUPO) and Recovery Order (RO) workflows in August;

Business support tools

The FCH 2 JU decided to adopt ARES, the registration and document management system used by the EC. The preparatory work took place during the first semester of 2018 with the effective migration in June.

An assessment in June of the possibility to adopt the e-Invoicing and e-tendering workflows from DIGIT led to the conclusion that it would be cost efficient to gradually adopt the complete e-PRIOR[120] processes. Consequently, in October, the FCH 2 JU signed the MoU and the first electronic invoices were processed in December.

The FCH 2 JU continued to use the shared Innovative Medicines Initiative Joint Undertaking JU (IMI JU) cloud application platform for time management and selection procedures and in July confirmed its interest in participating in the new wave of SYSPER implementation. The Service Level Agreement was signed in November and the kick-off meeting will be held in January 2019.

Cloud-hosting services were contracted through another existing Inter-Agency Framework Contract and the transfer to the new provider was organised in December. In this context, the IT TRUST platform for the dissemination of FCH technologies information and results is also using cloud technology hosting.

In December, the FCH 2 JU website hosting was transferred to DIGIT under the Next-Europa service to ensure the stability and continuity of this essential tool for the external communication and visibility of the FCH programme. In this context, discussions have been pursued with Hydrogen Europe and Hydrogen Europe Research to revise the cooperation on the project database to ensure alignment with EC requirements.

FCH internal support

The specific contract under the EC Framework Contract TESTA NG II for the provision of the secured telecommunications line was signed during the last quarter of 2018 to enable the continuation of services in 2019 for all Joint Undertakings.

The Framework Contract for the IT Managed Services was signed in October 2018 by the Executive Director following the signature in May of the MoU by the six Joint Undertakings hosted in the White Atrium building, thereby setting the role and responsibilities for the conduct of the procedure and the management and implementation of the contract. The first specific contract for the associated services entered into force on 1 January 2019.

The renewal of the wired and wireless network to cover the announced obsolescence, the current needs and, in particular, future expectations (wireless/mobile offices, future/digital workplace, etc.) is a common project under the IT annual work plan for the six JUs. The Wi-Fi site survey in the White Atrium building delivered in September resulted in a set of deliverables and design documents. The IT governance selected the best option in December and orders for new equipment have been placed under the EC Framework Contracts. The new IT service provider for the Framework Contract mentioned above will carry out the installation and configuration during the first quarter 2019.

Support was also provided at events using video broadcasting (such as info day, the financial workshop, CSC communication workshop and general assemblies for the Regions Initiative).

120 e-PRIOR is an open source e-Procurement platform that allows public administrations to implement interoperable electronic services.

Logistics

In addition, logistical support has been provided in the context of general administration. It encompasses the management of supply and maintenance of equipment, namely stationery, goods and services for administration, and includes the monitoring of services provided in particular through the Office des Infrastructures de Bruxelles (OIB), the translation centre and the publication office.

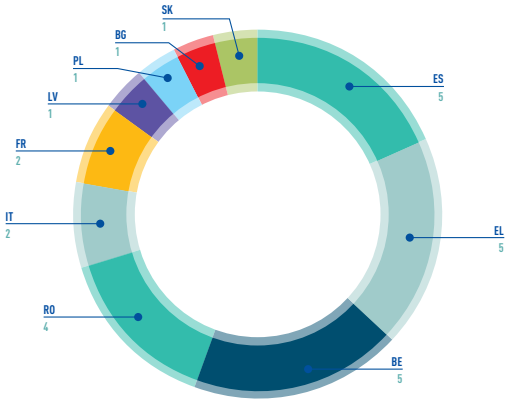
In 2018, a special focus was put on providing equipment for the meeting room covering the necessary audio-visual and web conference services, given the support offered by the recent SCIC AV&C-2 Framework Contracts available to the JU in this context. The study delivered in November resulted in a set of deliverables and design documents. The related purchase orders for equipment, installation and programming were signed in December and implementation will be carried out during the first quarter 2019.

2.6 HUMAN RESOURCES

By the end of 2018, the FCH 2 JU PO comprised 27 team members (24 temporary agents and 3 contract agents) representing 10 different EU Member States.

The team is well balanced in terms of gender equality (51 % men and 49 % women) and ages range from 30 to 61 (average 43.6).

Graph 2.6.1: FCH 2 JU staff by nationalities



After the Communication Officer AST 4 resigned with effect from 31 March 2018, filling the Staff Establishment Plan was assured by completing an external selection procedure and recruiting a new staff member who started on 1 July 2018.

Another external selection procedure was completed to fill the newly opened vacancy of Personal Assistant to the Executive Director CA FG II (who started work on 1 June 2018).

The PO is also looking forward to filling two seconded national expert (SNE) posts through an external selection procedure launched in September 2018.

Details of the Staff Establishment Plan are shown in Annex 2.

To provide support to the PO in the areas of communication and knowledge management, three short-term contracts for interim services were used in 2018. The PO also benefited from the contribution of the two paid trainees who each spent six months in the office supporting the work in both units.

The PO depends on the expertise and motivation of its staff to achieve its goals. In 2018, emphasis was continuously put on **learning and development** by identifying training needs and promoting professional development through training opportunities.

On 26 January 2018, the FCH 2 JU GB adopted the FCH 2 JU Framework for Learning and Development. In accordance with this framework, a new learning and development policy was adopted by the Executive Director on 20 December 2018, setting out the main principles and identifying the learning and development priorities for the PO in the upcoming years.

A training session on effective communication and team development, called 'Moving forward together', was attended by all staff during the annual **team-building event** organised on 19 September 2018.

Individual training needs were identified during the annual appraisal exercise in order to manage talents and ensure consistency in the professional and personal development of all staff in line with the PO's mission and tasks. This included both classroom and online training in languages, general soft skills and H2020 training, as well as on specific topics related to their current job for individual staff members. In the context of the introduction of the ARES document management system in the second half of 2018, several training sessions were organised for all staff to familiarise them with the functionalities of the new tool.

A training session on anti-fraud prevention was delivered by the European Anti-Fraud Office in November 2018 to raise awareness among the staff regarding the investigative process and, in particular, issues arising in procurement procedures.

The Reclassification Exercise 2018 was carried out and the decision on staff reclassified (four temporary agents) was adopted with reclassifications taking effect retroactively on 1 January 2018.

Following up on the implementing rules on staff regulations, the following decisions were adopted via written procedures by the FCH 2 JU GB during 2018:

- on Framework for Learning and Development (26/01/2018)
- on Temporary occupation of management posts (31/07/2018)
- on Guidelines on whistleblowing (21/11/2018)
- on Function of adviser (21/11/2018)
- on Middle management staff (21/11/2018)
- on Outside activities and assignments and on occupational activities after leaving the service (21/11/2018).

03
GOVERNANCE

3.1 GOVERNING BOARD

The FCH 2 JU governing board (GB) is composed of three representatives from the EC representing the EU, six representatives from Hydrogen Europe and one from Hydrogen Europe Research. In February 2018, Valérie Bouillon-Delporte was elected as the chair until the end of her predecessor's mandate and was re-elected in October with a two-year mandate. Also in February, Signe Ratso was elected as the vice-chair until the end of her predecessor's mandate. Following a reorganisation at DG RTD, she was replaced by Patrick Child, Deputy Director-General of DG RTD, who was elected in July as the new vice-chair with a two-year mandate. In October, one representative from Hydrogen Europe was replaced by Wolfram Schwab, Alstom Transport.

During the year, the FCH 2 JU GB had four meetings: 6 February, 22 March, 3 July and 25 October. The first meeting was mainly dedicated to reviewing the strategic orientations framing the AWP 2019-2020. The July meeting included a presentation on the outcome of call 2018 evaluations, which were subject to a written procedure for adoption of the call results by the FCH 2 GB (see below). In October, a follow-up of the implementation of the recommendations of the FCH 2 JU interim evaluation under H2020 was presented. All the meetings focused on strategic issues and discussions on the progress of the programme, projects and initiatives (such as the studies or the regions initiative).

The FCH 2 JU GB also adopted major decisions by written procedure, including the following:

- Adoption on 26 January 2018 of the FCH 2 JU Learning and Development Framework;
- Approval on 15 March 2018 of the IAS Mission Charter;
- Endorsement on 22 March 2018 of the action plan on recommendations of the interim evaluation of the FCH 2 JU under H2020;
- Adoption on 4 April 2018 of the first FCH 2 JU 2018 budget amendment;
- Approval on 4 June 2018 of the assessment of the level of aggregated in-kind contributions in operational activities (IKOP) (FP7) at 31 December 2017;
- Endorsement of the addendum to the MAWP 2014-2020;
- Opinion on 29 June 2018 on the annual accounts of the FCH 2 JU for the year 2017;
- Assessment and approval on 29 June 2018 of the FCH 2 JU 2017 AAR;
- Adoption on 31 July 2018 of the implementing rules on temporary occupation of management posts;
- Adoption on 8 August 2018 of call 2018 results (list of proposals selected for funding, list of proposals on the reserve list and list of proposals rejected);
- Adoption on 16 August 2018 of the revised FCH 2 JU Internal Control Framework;
- Adoption on 21 November 2018 of four implementing rules: on outside activities, on the function of advisor, on middle management and on guidelines on whistleblowing;
- Adoption on 17 December 2018 of the FCH 2 JU AWP and Budget for 2019.

More information on the role and composition of the GB is available at: http://www.fch.europa.eu/page/governing-board

3.2 EXECUTIVE DIRECTOR

According to Article 9 of the FCH 2 JU statutes, the Executive Director is the legal representative and the chief executive responsible for the day-to-day management of the FCH 2 JU in accordance with the decisions of the GB.

Bart Biebuyck was appointed as Executive Director by the FCH 2 JU GB and took up his duties on 16 May 2016.

3.3 STATES REPRESENTATIVES GROUP

During 2018, the States Representatives Group (SRG) met on 17 May and 13 November. Among other things, its activities focused on monitoring the achievements and results of the FCH 2 JU, with particular attention being paid to the following:

1. Industry representatives were invited to give presentations at the May meeting. The participants shared the vision and ambition of industry through to 2030 and the needs in terms of the next Framework Programme. The objectives are to enhance deployment of FCH products, continue and strengthen innovation, and secure a European supply chain. Industry stated that this can only become reality if Member States provide active support. The key role of Member States in market activation was also highlighted.

2. Recommendations on the SRG were made in the interim report of the FCH 2 JU, with the objective of enhancing the work and interactions of the SRG. As a result, in summer 2018 a survey was conducted to study the levels of interaction of the SRG representatives within their respective bodies, the appropriateness of the communication received from the FCH 2 JU and possible additional steps that could be taken.

The conclusions from the survey include:

- Most countries do not have a dedicated deployment strategy for FCH technologies;
- About two in three of the representatives who replied are employed directly by their respective national ministries; one-third are attached to R&D centres;
- SRG representatives have some degree of influence on funding, strategy and legislation, but they are mostly limited to making recommendations. A number of them implement funding programmes;
- Almost all the representatives think the level of information available to them is sufficient.

The recommendations of the survey respondents for the near-term (H2020) and long-term (Horizon Europe) future are quite varied, but some stand out:

- More input into the AWP and MAWP
- More power in the decision-making process, i.e. in the GB
- Improved collaboration and communication, both internally (within the SRG) and externally (with other relevant bodies, e.g. EC, other ministerial departments, etc.).

3. Some Member States expressed the view that a coordinated approach to a dedicated deployment programme, with the necessary funding support from the EC, is required to achieve the objectives set out by the 14 Member States. These objectives were submitted by the countries in their respective National Policy Frameworks as a result of the Alternative Fuels Infrastructure Directive and the aim is to establish close to 800 HRS by 2025.

4. Member States requested information from the EC on the status of the possible continuation of the FCH 2 JU programme within Horizon Europe. The EC provided an overview of progress, as well as an indication of the next steps. The SRG agreed to work on a joint position paper from Member States regarding this topic, to be issued in early 2019.

During 2018, the SRG was consulted on developing call topics and documents and on AWP 2019. In December, the GB validated a set of answers provided by the Coordinators' Group to the questions/comments raised by the SRG.

3.4 SCIENTIFIC COMMITTEE

The Scientific Committee (SC) is an advisory body to the GB and comprises a maximum of nine members. These members reflect a balanced representation of globally renowned expertise from academia, industry and regulatory bodies. The role of the SC is to provide: (a) advice on scientific priorities to be addressed in the annual work plans; and (b) advice on scientific achievements described in the annual activity reports. The SC held two meetings in the first half of 2018 in order to provide the GB with advice on both of the above-mentioned actions. The chairperson attended the board meetings (in March and June 2018) and took part in its discussions, but had no voting rights. An additional informal meeting was held during the PRD event in Brussels (November 2018), followed by a teleconference discussion in December, to provide the GB with advice on scientific priorities for 2020 Work Plan.

3.5 STAKEHOLDERS FORUM

The Stakeholders Forum is one of the FCH 2 JU key governance bodies, which ensures the transparency and openness of the FCH 2 JU programme for all stakeholders, including the public. It also provides opportunities to enhance FCH 2 JU communication activities, as it brings together a large number of policymakers and EU stakeholders. In 2018, after more than 10 years in existence, the 11th edition of the FCH 2 JU Stakeholders Forum was a good occasion to build on the many success stories and look forward to exploring how to achieve a hydrogen economy through sectoral integration in the EU and worldwide. The first edition of the FCH 2 JU awards was also presented at this event ('best success story' and 'best innovation' awards were given to FCH 2 JU projects). For more information on the Stakeholders Forum in 2018 (including the awards), please see Section 2.1.2.

04
INTERNAL CONTROL FRAMEWORK

In August 2018, the GB adopted the revised FCH 2 JU Internal Control Framework (ICF). The new framework is based on the revised EC framework and consists of five internal control components and 17 principles based on the COSO 2013 Internal Control-Integrated Framework.

The internal control components[121] underpin the structure of the ICF and support the FCH 2 JU in its efforts to achieve its objectives.

In order to facilitate the implementation of the ICF and management's assessment of whether each component is present and functioning, and whether the components function well together, each component consists of a set of principles. Assessments based on these principles help to provide reasonable assurance that the FCH 2 JU's objectives are being met. The principles specify the actions required for internal control to be effective. The characteristics of each principle are defined to assist the management in implementing internal control procedures and in assessing whether the principles are present and functioning.

In December 2018, the manager in charge of risk management and internal control carried out an assessment to ensure that all the principles are present and functioning. The ensuing action plan is included in AWP 2019 and its implementation will be reported in AAR 2019.

In addition, the FCH 2 JU ICF provides for handover reports, briefings, monthly reporting on specific topics (such as budget execution, financial management and monitoring of KPIs and reporting at weekly management meetings. The review of the year and declaration of assurance of each head of unit are included in their input into the AAR and in a review by the internal control coordinator of the state of the internal control system (see Sections 4.6 and 5.2).

4.1 FINANCIAL PROCEDURES

The financial procedures guide FCH 2 JU operations and set out how the JU uses and manages its funds and resources.

The activities in 2018 included the following:

- Effective implementation of the newly developed COMPASS work flows (audit implementation, project monitoring for the assessment of H2020 periodic reports, recovery order);
- Active communication and cooperation with the CSC, through participation in various working groups with the aim of enhancing a common understanding and interpretation of the requirements of newly developed work flows for H2020 in the context of the FCH 2 JU environment;
- An update of the internal procedure for review and assessment of FP7 periodic reports carried out in November 2018.
- The FCH 2 JU ensured implementation of the common anti-fraud strategy of the Research family adopted on 18 March 2015 by the CSC, by organising in-house training on anti-fraud. The training took place in November 2018 and was delivered by OLAF. The FCH 2 JU has an anti-fraud correspondent and encourages its employees to take part in the anti-fraud training organised by DG RTD.

4.2 *EX-ANTE* CONTROLS ON OPERATIONAL EXPENDITURE

Ex-ante controls are essential to prevent errors and avoid the need for *ex-post* corrective action. In 2018, the FCH 2 JU continued to apply the provisions of Article 66 of the Financial Regulation and Article 18 of FCH 2 JU Financial Rules: '*each operation shall be subject at least to an ex-ante control based on a desk review of documents and on the available results of controls already carried out relating to the operational and financial aspects of the operation*'.

Therefore, the main objective of *ex-ante* controls is to ascertain that the principles of sound financial management have been applied.

121 Control environment, risk assessment, control activities, information and communication, monitoring activities.

The FCH 2 JU has developed and continues to apply well-developed procedures defining the controls to be performed by project and finance officers for every cost claim, invoice, commitment and payment, taking into account risk-based and cost-effectiveness considerations.

In 2018, an additional *ex-ante* measure was introduced in the form of webinars focused on the specificities of each project. In addition, specific attention was paid to:

- Participation of project and finance officers at H2020 project kick-off meetings in order to clearly communicate the financial reporting requirements;
- Increased financial checks during the Grant Agreement Preparation (GAP) phase;
- Reinforced monitoring and targeted checks during *ex-ante* controls for interim and final payments in accordance with the H2020 *ex-ante* control strategy, as published by the CSC Steering Board on 8 June 2017.
- On 21 March 2018, the FCH 2 JU organised the third financial workshop on H2020 financial rules and prevention of errors, focusing on the specificities and business models that are pertinent for FCH 2 JU projects. All successful participants from the H2020 calls were invited to the session. The workshop presented a series of quizzes that facilitated interaction with the participants. It was attended by 73 people (including online participants). The presentations are available on the FCH 2 JU website: http://www.fch.europa.eu/page/h2020-financial-workshops.

4.3 *EX-POST* CONTROL OF OPERATIONAL EXPENDITURE AND ERROR RATES IDENTIFIED

Ex-post controls are defined as the controls executed to verify the financial and operational aspects of finalised budgetary transactions in accordance with Article 19 of the FCH 2 JU Financial Rules.

The controls are the last stage of the JU's control strategy in a project life cycle. This stage includes *ex-post* audits as well as the recovery/correction of any amounts found to have been paid in excess of the sum due.

The main objectives of the *ex-post* controls are to ensure that legality, regularity and sound financial management (economy, efficiency and effectiveness) have been respected and to provide the basis for corrective and recovery activities, if necessary.

FP7 programme

The FCH 2 JU *ex-post* controls of FCH FP7 grants included financial audits carried out by external audit firms.

The main activities of *ex-post* controls include management of FP7 *ex-post* audits of beneficiaries via a contract with external audit firms, and implementation of the FP7 *ex-post* audit strategy to ensure appropriate audit coverage of the cost claims validated.

At the same time, a primary goal of FP7 *ex-post* controls was to achieve performance efficiency, i.e. trying to minimise the costs of audits while maintaining targeted and appropriate audit coverage.

In 2018, in line with the multi-annual FP7 *ex-post* audit strategy of the FCH 2 JU, the following new audits were launched:

- Three representative audits, covering the FCH 2 JU's top beneficiaries not previously audited under the FP7 programme, and two randomly selected beneficiaries to ensure representative results;
- Three risk-based audits as part of a corrective strand of the FP7 *ex-post* audit strategy of the FCH 2 JU.

For execution of the FP7 audits in 2018, the FCH 2 JU used a new framework contract concluded with two other JUs in the course of 2018 (cascade system).

After conflict of interest and capacity checks, it signed a specific contract for batch audits with the external audit firm Lubbock Fine.

Because of its multi-annual nature, the effectiveness of the FCH 2 JU's control strategy can only be fully measured and assessed during the final stages of the JU's programme, once the *ex-post* control strategy has been fully implemented, and systematic errors have been detected and corrected.

During this stage, the main legality and regularity indicator is the 'error rate' detected by *ex-post* audits. The following two aspects must be considered when providing information on error rates and inferring conclusions from such errors:

- Due to the multi-annual perspective of *ex-post* audits, their effectiveness must be measured by presenting '**cumulative**' information on the errors detected;
- **Two types of *ex-post* audits** must be distinguished with **two different objectives**: 'representative' audits with a goal of producing a representative estimate of the error rate present in the population, and 'corrective' audits (e.g. risk-based audits) with the objective of detecting and correcting as many errors as possible.

Bearing in mind these two aspects, three types of cumulative error rates are calculated to provide a comprehensive overall view of the results of *ex-post* audits (see Table 4.3.3). For each type of error, the rate is calculated at both the 'total cost' and at the 'FCH 2 JU contribution' level. This distinction is necessary as not all errors detected at total cost level have a financial impact on the FCH 2 JU contribution[122].

Overall error rate

This is the error rate derived from all audits, comprising both 'representative' and 'risk-based' audits. It is calculated as a percentage of the value[123] of the errors detected divided by the value of total costs accepted by the JU.

It provides information on the importance of the errors detected, but it cannot be used as a reference for inferring conclusions on the expected error in the non-audited population, for the following reasons: i) it is the result of 'representative' and 'risk-based' audits with two different objectives; and ii) as it is based on values, it is easily influenced by the error rates resulting from the individual audits of the cost claims of the highest values, which may not necessarily be those most representative for inferring conclusions.

Residual error rate

This is the level of error remaining in the population after corrections and recoveries made by the FCH 2 JU. This includes the extrapolation of audit results to non-audited contracts and the correction of errors. The formula for the calculation of the residual error rate, in line with the *ex-post* strategy and shown in Annex 9, is based on the following assumptions: i) all the errors detected will be corrected; and ii) the residual error rate for participations subject to extrapolation is estimated to be equal to the non-systematic error rate.

Ex-post audit resources

The lean structure of the FCH 2 JU does not allow for the setting up of an internal *ex-post* audit section, therefore all *ex-post* audits are outsourced to external audit firms.

Whereas the execution of the audit work is externalised, some of the JU's staff (*ex-post* audit team) are responsible for managing *ex-post* audits, in particular the following three processes:

- Planning (i.e. selection of 'representative' and 'risk-based' audits, coordination with EC audits and preparation of audit input files);
- Monitoring (i.e. regular follow-up of audit status, interaction with audit firms on technical questions, and more importantly, quality checks of audit reports);
- Evaluation/implementation of audit results (i.e. inferring conclusions on the basis of identified error rates, extrapolation procedures and initiation of recovery orders/offsetting with future payments to correct errors detected).

122 For example, an error detected on indirect costs (at total cost level) for a beneficiary using the 'actual' indirect cost method but with a maximum reimbursement rate of 20 % could have no impact on the FCH 2 JU contribution if 'declared' and 'eligible' indirect costs are above the 20 % reimbursed by the JU.

123 When considering the value of errors detected, three calculations are provided: i) with only the errors in favour of the JU (i.e. ineligible costs detected by the auditors; the JU has to recover the unduly paid funds, and these errors are expressed in negative values); ii) with only the errors in favour of the beneficiary (i.e. additional eligible costs identified by the auditors and not declared by the beneficiary, who can submit an additional cost claim, and additional payment by the JU is subject to certain conditions; these errors are expressed in positive values); and iii) with the total net value of errors (in favour of both the JU and the beneficiary).

The following table gives an overview of the resources devoted to *ex-post* audits:

TABLE 4.3.1: RESOURCES DEVOTED TO *EX-POST* AUDITS

	2011	2012	2013	2014	2015	2016	2017	2018
Internal resources *ex-post* audits[124]	1 FTE	15 FTE	2 FTE	2 FTE	1.5 FTE	2 FTE	2 FTE	1 FTE
Cost of externalised audits (commitments, in EUR)	77 820	208 665	161 082	245 081	315 716	206 762	194 949	75 600

Ex-post audits – coverage

The FCH 2 JU FP7 *ex-post* audit strategy was adopted by the GB on 6 January 2011 and its implementation began in September 2011.

The following table gives an overview of the number of *ex-post* audits and their audit coverage:

TABLE 4.3.2: NUMBER OF AUDITS AND AUDIT COVERAGE, CUMULATIVE[125]

BATCH	YEAR	TO BE LAUNCHED	ON-GOING	FINALISED	TOTAL	OF WHICH	
						REPRESENTATIVE	RISK-BASED
1st batch	2011	0	0	5	5	5	0
2nd batch	2011	0	0	7	7	6	1
3rd batch	2012	0	0	9	9	7	2
4th batch	2012	0	0	12	12	12	0
5th batch	2013	0	0	15	15	11	4
6th batch	2014	0	0	20	20	15	5
7th batch	2014	0	0	2	2	0	2
8th batch	2015	0	0	29	29	27	2
9th batch	2016	0	0	18	18	16	2
10th batch	2017	0	6	10	16	12	4
11th batch	2018	0	7	1	8	5	3
Total (audits)		**0**	**9**	**132**	**141**	**116**	**25**

Total (cost claims)	**563**
Total costs accepted by FCH 2 JU (*cumulative*) (in EUR) **(A)**	802 750 660
Total costs of audits launched (*cumulative*) (in EUR) **(B)**	181 855 641
Total costs of audits finalised (*cumulative*) (in EUR) **(C)**	155 227 890
Direct audit coverage of total audits (in %) **(B/A)**	23 %
Direct audit coverage of finalised audits (in %) **(C/A)**	19 %
Total FCH 2 JU beneficiaries **(D)**	585
FCH 2 JU beneficiaries audited **(E)**	139
Audit coverage (number of benef.) of total audits (in %) **(E/D)**	24 %

124 Due to the lean structure of the FCH 2 JU, and for cost-efficiency reasons, there is no single function in the JU fully dedicated to the management of *ex-post* audits. The reported figure in 'FTE: full-time equivalent' is therefore an estimation of the time devoted by various members of the JU staff to *ex-post* audits to manage the three processes under the JU's responsibility (i.e. planning, monitoring/quality checks, and evaluation/implementation of audit results).

125 By 31 December 2018, there were two open audits from batch 10, launched in 2017. The FCH 2 JU did not finalise these audits due to ongoing discussions with the beneficiaries that also required coordination with other DG RTD services (under FP7) to ensure coherent audit results across different stakeholders vis-à-vis the same beneficiary.

The first cost claims were received by the FCH 2 JU in the spring of 2011 and the first *ex-post* audits were launched immediately after the JU's validation of the first claims. In the calendar year 2011, two batches were launched: the first (five audits) in September 2011 and the second (seven audits) in December 2011. During 2012, two additional batches were launched: the third (nine audits) in February 2012 and the fourth (12 audits) in December 2012. In 2013, one batch was launched: the fifth (15 audits) in May 2013. In the calendar year 2014, two additional batches were launched: the sixth (20 audits) in May 2014 and the seventh (two audits) in October 2014. In 2015, the eighth batch (29 audits) was launched, of which 27 were considered as representative audits and two were launched on request as part of the risk-based strategy.

In 2016, batch 9 was launched with 16 representative and two corrective audits, with the aim of optimising the total cost of audits while maintaining appropriate audit coverage (resulting in overall direct audit coverage of 24 % in 2016, compared to 22 % in 2015). For corrective audits, the FCH 2 JU selected two beneficiaries, previously audited at the very beginning of the FP7 audit campaign, for a follow-up audit to ensure proper implementation of the previous audit findings and recommendations.

In 2017, it launched the 10th batch of 16 FP7 audits, 14[126] of which were closed by 31 December 2018 and considered for the error-rate calculation.

Following the signing of the new Framework Contract for FP7 *ex-post* audits in 2018, a new 11th batch could only be launched later in 2018, enabling 1 out of 8 launched audits to be concluded.

By 31 December 2018, all previous batches had been finalised.

In conclusion, since launching the FP7 *ex-post* audits, 141 audits have been launched of which 116 were 'representative' and 25 'risk-based', covering in total EUR 181.86 million of accepted costs declared by the beneficiaries, with an average sum of EUR 1.29 million of accepted costs per individual audit.

This resulted in direct audit coverage of 24 %, from all validated costs claims by the FCH for all 155 projects totalling EUR 802.75 million since the beginning of the FP7 Programme (up to 31 December 2018).

Ex-post audits – error rates

The error rates resulting from the 132 finalised audits (of which 111 are representative and 21 are risk-based) are as follows:

TABLE 4.3.3: INDICATORS OF ERROR

	ACHIEVED CUMULATIVE PERIOD (AS AT 31/12/2018)	
	TOTAL COST	FCH 2 JU CONTRIBUTION
Costs accepted by FCH 2 JU Financial Officers (FO) (in EUR) (**A**)	120 387 680	55 398 994
Overall errors (in EUR) in favour of the FCH 2 JU (**B**)	-4 732 825	-1 726 062
'Overall Error rate' (only in favour of the FCH 2 JU) (**B/A**)	**-3.93 %**	**-3.12 %**
Overall errors (in EUR) in favour of the beneficiary (**C**)	3 698 186	1 155 810
'Overall Error rate' (only in favour of the beneficiary) (**C/A**)	**3.07 %**	**2.09 %**
Total Overall errors (in EUR) (in favour of the FCH 2 JU and in favour of the beneficiary (**D**)	-1 034 639	-570 252
'Overall Error rate' (netting off errors in favour of the JU and of the beneficiary (**D/A**)	**-0.86 %**	**-1.03 %**
'Representative error rate' (formula in Annex 9) (%)	**-2.64 %**	**-2.09 %**
'Residual error rate' (formula in Annex 9) (%)	**-1.15 %**	**-1.10 %**

The difference between the 'representative error rate' and the 'residual error rate' is the result of the following: i) the correction of errors in an important part of the population due to the high audit coverage; and ii) the effect of extrapolation of audit results to non-audited cost claims of audited beneficiaries.

126 In 2016, for the first time the FCH 2 JU launched an audit of two previously audited beneficiaries (from batch 1); therefore, the total number of beneficiaries audited is lower than the total number of audits launched under the FP7 audit campaign.

In 2018, the overall 'net error rate'[127] on costs of 0.86 % remains similar to 2017 (-0.78 %) and, more significantly, an overall 'net error rate' on the FCH contribution (directly affecting the EC budget) fell to 1.03 %, compared to 1.44 % in 2017.

Based on the calculation formula (derived from the FP7 *ex-post* audit strategy, and coherent with the overall RTD FP7 *ex-post* audit strategy – see Annex 9), for the representative error rates, where all positive audit adjustments (i.e. adjustments in favour of the beneficiaries) appear as zero adjustments, whereas all negative audit adjustments appear as their exact value, the representative error rate on total costs audited fell from 2.73 % (in 2017) to 2.64 % in 2018. The representative error rate on the FCH contribution (following the same calculation formula) decreased from 2.14 % (in 2017) to 2.09 % in 2018.

In 2018, the FCH was able to achieve a most decisive stable '**residual error rate**' (following the materiality criteria of 2 % threshold for AAR reservation) **of 1.15% on the total costs audited** (compared to -1.13 % in 2017) **and of –1.10% on the FCH contribution** (compared to -1.09 % in 2017).

Further analysis of the error rates and whether or not a reservation is necessary in the declaration of assurance concerning the accuracy of the cost claims is addressed in Section 5.3.

Most common audit findings

For the direct costs, most of the findings in the audits related to an incorrect calculation of the hourly rates applied by the beneficiaries to calculate personnel costs.

The FCH 2 JU has learnt lessons from the most common audit errors and, as part of the preventive measures, during the *ex-ante* process the FCH team is focusing on proper explanations of correct interpretations of the applicable financial rules for the beneficiaries.

For the indirect costs, the findings related mainly to incorrect calculations (inclusion of ineligible costs) or to the use of budgeted rather than actual indirect cost figures. These errors are completely avoided in the H2020 programme, which introduces a 25 % flat rate on indirect costs.

Implementation of audit results

As a result of errors identified during the FCH 2 JU *ex-post* audits, JU funds paid unduly must be recovered. The FCH 2 JU has implemented the necessary controls and monitoring mechanisms to ensure that all errors detected in favour of the JU are corrected in due course (either through a recovery order or by offsetting a future payment).

The detailed situation on the implementation (at project level) of *ex-post* audit results is given below:

TABLE 4.3.4: IMPLEMENTATION OF *EX-POST* AUDIT RESULTS IN FAVOUR OF THE FCH 2 JU (IN EUR)

SUMMARY OF NEGATIVE AUDIT ADJUSTMENTS. BENEFICIARIES WITH PRE-FINAL AUDIT REPORT APPROVED BY 31/12/2018						
AUDIT LAUNCHING YEAR	AUDIT ADJUSTMENT (IN FAVOUR OF FCH 2 JU)		ADJUSTMENTS PENDING IMPLEMENTATION		ADJUSTMENTS IMPLEMENTED	
	ON TOTAL COSTS	ON FCH 2 JU CONTRIBUTION	ON TOTAL COSTS	ON FCH 2 JU CONTRIBUTION	ON TOTAL COSTS	ON FCH 2 JU CONTRIBUTION
2011	824 960	214 492			824 960	214 492
2012	629 111	346 512			629 111	346 512
2013	138 734	66 592			138 734	66 592
2014	1 096 153	486 361			1 096 153	486 361
2015	1 359 941	314 708	140 051	23 233	1 219 890	291 475
2016	324 005	102 066	22 145	12 149	301 860	89 917
2017	278 064	128 528		6 206	278 064	122 322
2018						
TOTAL	**4 734 901**	**1 684 785**	**0**	**6 206**	**4 734 901**	**1 678 579**
NOTE:	The total amount of negative adjustments (4 734 901) does not match with the same total in Table 4.3.3 (4 732 825) because in this table the information is at the level of project (in order to indicate afterwards the amount implemented, which is always by project), whereas in Table 4.3.3 the information is given at the level of beneficiary.					

127 Net error rate: an error rate taking into account the net amount of positive and negative adjustments on the total audited costs/total audited FCH contribution.

At the cut-off reporting date (i.e. 31 December 2018), the percentages of total adjustments effectively implemented are close to 100 % at both total cost and FCH 2 JU contribution level. These percentages prove the continuous timely implementation of audit results, and consequently the effective correction of errors detected by the FCH 2 JU. Indeed, the vast majority of the adjustments with pending implementations are not due to JU delays, but can simply be explained by the fact that the audits have been finalised recently and implementation will follow shortly.

As can be seen in the table above, the FCH 2 JU has implemented the results from all the audits launched before 2017.

To date, the FCH 2 JU has focused its *ex-post* audit effort on finalising a representative number of audits in order to have sufficient information for the calculation of a 'representative error rate' in preparation for the 2018 AAR.

Implementation of extrapolation/'extension of audit findings'

Extension of the audit findings (formerly known as 'extrapolation') is the process whereby 'systematic' errors detected in audited cost claims are 'extrapolated' to all other non-audited FCH 2 JU claims from the same audited beneficiary. The timely implementation of 'extension of audit findings' relies on beneficiaries preparing and submitting revised cost claims from which the effect of any systematic error(s) detected in audits has been eradicated.

The overall situation on the implementation of the extension of audit findings is given below:

TABLE 4.3.5: IMPLEMENTATION OF 'EXTENSION OF AUDIT FINDINGS' OF *EX-POST* AUDIT RESULTS

	BENEFICIARIES	COST CLAIMS
Audits finalised	132	
Letters of conclusion sent as of reporting date	131	
Of which potentially concerned by extrapolation	43	
Extrapolation feedback not received from beneficiary	0	
Extrapolation feedback received from beneficiary	43	153
Of which projects not affected		72
Of which projects affected		81
Of which non-implemented		3
Of which implemented		78

At the cut-off reporting date (31 December 2018), 43 of the 132 finalised audits were potentially affected by extrapolation. Feedback was received from all the beneficiaries, who provided the necessary information for 153 cost claims. Of these, 81 were affected by an extension of audit findings, and the FCH 2 JU implemented the extrapolation in 78 of these (96 %).

Liquidated damages[128]

Liquidated damages are applied systematically by the FCH 2 JU. In some cases, they do not result in a recovery order due to application of the *de minimis* rule.

At the cut-off reporting date (31 December 2018), 36 of the 132 finalised audits were assessed as requiring liquidated damages for a total amount of EUR 144 813. Pre-information letters (i.e. letters of conclusion) were sent to beneficiaries in all 36 cases, and recovery orders have already been issued and cashed for 35 cases, for a total value of EUR 121 285.

128 Liquidated damages will only be applied where the unjustified contribution exceeds 2 % of the total contribution claimed for the given period.

H2020 programme – *ex-post* controls, H2020 audit strategy and cooperation with the CSC

Ex-post controls of operational expenditure for H2020 are designed and implemented in line with the Horizon 2020 *Ex-Post* Audit Strategy[129]. The Horizon 2020 CSC developed this audit strategy in cooperation with all of its clients (i.e. the entities that implement the Horizon 2020 budget: EC services, executive agencies and joint undertakings).

The Common Audit Service (CAS) of the Common Support Centre (CSC) ensures the harmonised implementation of the H2020 *Ex-Post* Audit Strategy for the EU's research and innovation expenditure, serving all 20 different H2020 stakeholders. The CAS uses the IT tool AUDEX for audit process management.

Its mission is to deliver a corporate approach for the audit cycle: audit selection, planning, application of rules, relations with beneficiaries, and management information on the audit process.

The main objective of the audit strategy is to provide the individual authorising officers with the necessary elements of assurance in a timely manner, thereby allowing them to report on the budget expenditure for which they are responsible. *Ex-post* controls on operational expenditure contribute in particular to:

- Assessing the legality and regularity of expenditure on a multi-annual basis
- Providing an indication of the effectiveness of the related *ex-ante* controls
- Providing the basis for corrective and recovery mechanisms, if necessary.

The FCH 2 JU is effectively integrated in this control chain: it participates in the audit process definition and in the monitoring of its implementation in close cooperation with the CAS and its clients. The main objectives of this cooperation are to align operations and exploit synergies on the common audit effort. The efficiency gains will reduce audit costs and the administrative burden on auditees, always in line with the specific objectives explained above for *ex-post* controls.

The implementation of all *ex-post* audit results remains the responsibility of the FCH 2 JU.

The FCH 2 JU also ensures the implementation of the research community's common anti-fraud strategy. The main actions derived from the strategy include the organisation of awareness-raising sessions within the JU and cooperation with OLAF (in the case of risk-based audits conducted by the CAS or outsourced contractors). Implementation of the action plan derived from the strategy is monitored by the FAIR – see also Section 4.1.

In 2018, the FCH 2 JU continued close cooperation with the CAS, resulting in the following main achievements:

510 Application of the JUs' sampling methodology for the second specific representative sample for the FCH 2 JU

511 Launch of the second two rounds of representative and corrective H2020 audits with FCH 2 JU cost claims

512 Agreement on the working arrangements for H2020 processes: Article 10[130]

513 Dialogue on harmonisation of the calculation of the individual representative error rates and residual error rates with the use of data provided by the CAS

514 Further development of the AUPR (AUdit PRocess) work flow in Sygma

515 Successful launch of the AURI (Audit Results Implementation) work flow for implementation of the audit results.

129 Ref. Ares(2016)981660 – 25/02/2016, endorsed by the CSC Steering Board.

130 Document was adopted by the CSC Executive Committee by written procedure on 31 January 2018.

H2020 *ex-post* audit methodology and error rates – corporate approach

The common representative sample (CRS) provides an estimate, via a representative sample of cost claims across the research and innovation family, of the overall level of error in the research FPs, across all services involved in its management. All of these grants follow the same homogeneous overall control system set out in this report.

The CRS is complemented by 'risk-based' audits; audits selected according to one or more risk criteria. These audits are intended to detect and correct as many errors as possible, for instance by targeting the larger beneficiaries and through the identification of possibly fraudulent operators. These audits are also referred to as 'corrective' audits.

Different indicators are calculated to provide a comprehensive view of legality and regularity:

Overall detected error rate: this is the error rate derived from the results of all audits, whether audits on a representative sample of beneficiaries or audits implemented for other reasons (large beneficiaries, preventive audits, risk factors, etc.). Its value is cumulative and can be calculated for a specific implementing body or for the whole research and innovation family.

Representative error rate for the Framework Programme: this is the error rate derived solely from the results of the CRS, extrapolated to the overall population and calculated for each FP as a whole. This error rate provides an estimate of the level of error in the given FP at the time of the audits but does not factor in the follow-up and corrections/recoveries undertaken by EC services after the audit, nor does it provide information on the net final financial impact of errors.

Residual error rate: the residual error rate, on a multi-annual basis, is the extrapolated level of error remaining after corrections/recoveries undertaken by EC services following the audits that have been made. The calculation of the residual error rate, as shown in **Annex 4**, is based on the following assumptions:

- All errors detected will be corrected;
- All non-audited expenditure of audited beneficiaries is clean of systematic material errors so that the residual error rate in this expenditure can be estimated to be equal to the non-systematic part of the representative error rate (for expenditure subject to extension of audit findings this is only assumed when the respective extension procedures have been closed).

The residual error rate develops over time and depends on the assumptions set out above. This indicator is reliable and acceptable for the purposes for which it was intended, i.e. as a legality and regularity indicator on the progress made, through its *ex-post* audit strategy, in dealing with errors on a multi-annual basis. However, it remains an estimate as long as not all cost claims have been received and not all cases of extension of audit findings have yet been fully implemented.

The H2020 audit strategy builds upon different layers of audits:

- A corporate layer consisting of a CRS[131] complemented by risk-based samples;
- An additional sample for entities with specific grant agreements or a separate discharge procedure and Article 10 audits at the demand of the JUs.

Based on the H2020 audit strategy, the CRS provides an estimate, via a representative sample of cost claims across the whole research and innovation family, of the overall level of error in the research FPs, across all services involved in its management.

In H2020, all 20 implementing entities are expected to follow the same homogeneous overall *ex-ante* control system[132].

131 Taken biannually for 162 participations; MUS sampling is applied; population is determined by the costs declared and paid by the beneficiaries through financial statements which form the basis for calculating the EU contribution.

132 Guidance H2020 *ex-ante* controls on interim and final payments, version 1.0.

At this stage of the programme life cycle, cost claims totalling EUR 9 billion of requested funding had been received by the services by the end of 2018. The first Horizon 2020 audits were launched in mid-2016 and further audits were launched in 2017 and 2018. Two CRS, common risk samples and additional samples[133] were selected. In total, by December 2018, 2 383 participations had been selected for audit, covering all the services signing grants in Horizon 2020.

In total, the audit of 1 155 participations had been finalised by 31 December 2018 (763 in 2018). This includes 164 of the 303 participations selected in the first 2 CRS. The error rate at 31 December 2018 is:

Overall detected error rate based on 1 155 participations: 1.62 %

The detected error rate[134] based on 164 of the 303 participations selected in the first and second CRS is 2.43 %. However, if we take into account the draft audit reports, then the expected representative error rate for the full sample will be around 3.32 %.

Residual error rate for the R&I family: 2.22 % (2.24 % for DG RTD alone), expected to rise to around 2.45 % when taking into account the draft audit reports.

FCH 2 JU specificities in the H2020 programme

Given the relatively small share of the FCH 2 JU's budget (EUR 665 million: 1 %) compared to the overall H2020 budget (EUR 63 584 million[135]: 100 %), the number of projects selected for *ex-post* audit by the CAS via the common representative sample is limited.

This observation was further confirmed by the fact that none of the FCH 2 JU participations were selected in CRS 1. In the second round of CRS, there were two FCH 2 JU participations directly hit by MUS sampling in 2018. The items hit by CRS are considered as representative for calculation of the FCH 2 JU specific error rates. The results of these two hits by CRS 2 are expected to be available by 31 December 2019.

Therefore, in line with Annex 1 to the H2020 audit strategy, the FCH 2 JU planned for additional audit sampling (i.e. JUs' specific sample) in order to ensure sufficient *ex-post* audit coverage and allow a representative error rate on FCH 2 JU expenditure to be calculated over time. This is necessary to provide reasonable assurance to the JU Executive Director in view of his declaration of assurance and the separate discharge procedure for the JU.

In 2018, the FCH 2 JU validated cost claims totalling EUR 72.32 million (EUR 53.93 million in 2017), of which EUR 58.65 million represented the EU contribution (EUR 37.09 million in 2017).

In 2018, the FCH 2 JU launched (in cooperation with the CAS) 14 representative audits, covering EUR 9.23 million (EUR 13.35 million in 2017) of costs and EUR 7.82 million (EUR 8.1 million in 2017) of the EU contribution (overall direct audit coverage of 18 % on costs and 17 % on the EC contribution[136]).

The following table and graphs provide a comprehensive view of H2020 expenditure, validated in the form of financial statements accepted by the FCH 2 JU, compared with the amount of costs and FCH contribution covered by the H2020 audits launched in 2017 and 2018.

TABLE 4.3.6: AUDIT COVERAGE OF ACCEPTED COSTS AND FCH CONTRIBUTION (2017-2018), IN EUR MILLION

2017

COSTS			FCH 2 JU CONTRIBUTION			NO OF PARTICIPATIONS
ACCEPTED BY FCH 2 JU	COVERED VIA AUDITS LAUNCHED	PERCENTAGE	ACCEPTED BY FCH 2 JU	COVERED VIA AUDITS LAUNCHED	PERCENTAGE	
53.93	13.35	24.76 %	37.09	8.02	21.64 %	15

133 This sampling accommodates the special needs of certain stakeholders with regard to audit coverage and selection method. In addition, top-ups, which are participations of selected beneficiaries that are added to the selected participations, are included in the total participations selected.

134 This error rate is not called 'common representative error rate' at this stage as the audits of the first CRS are not yet all finalised.

135 H2020 operational budget of EUR 70 280 million less EUR 6 696 million related to EIT (European Institute of Technology), financial instruments and others.

136 In line with the draft JUs' sampling methodology which provides for a target audit coverage of 20 %.

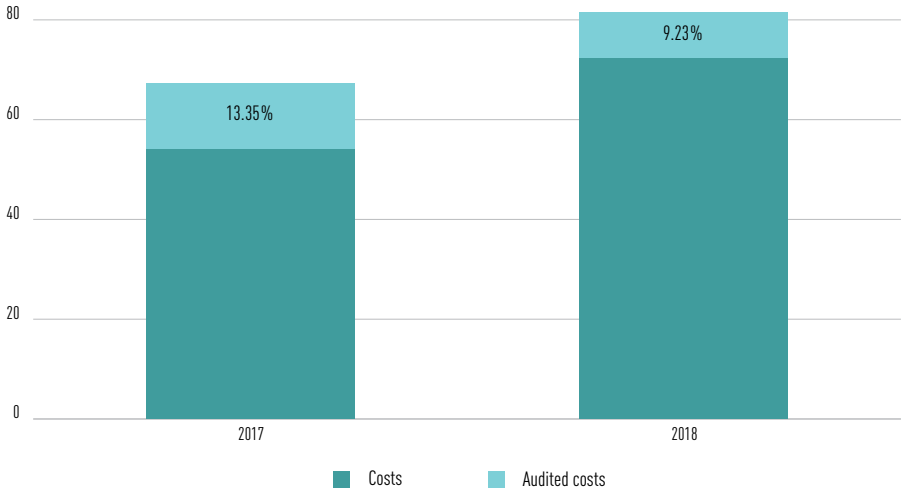
2018

COSTS			FCH 2 JU CONTRIBUTION			NO OF PARTICIPATIONS
ACCEPTED BY FCH 2 JU	COVERED VIA AUDITS LAUNCHED	PERCENTAGE	ACCEPTED BY FCH 2 JU	COVERED VIA AUDITS LAUNCHED	PERCENTAGE	
72.32	9.23	12.77 %	58.65	7.82	13.34 %	24

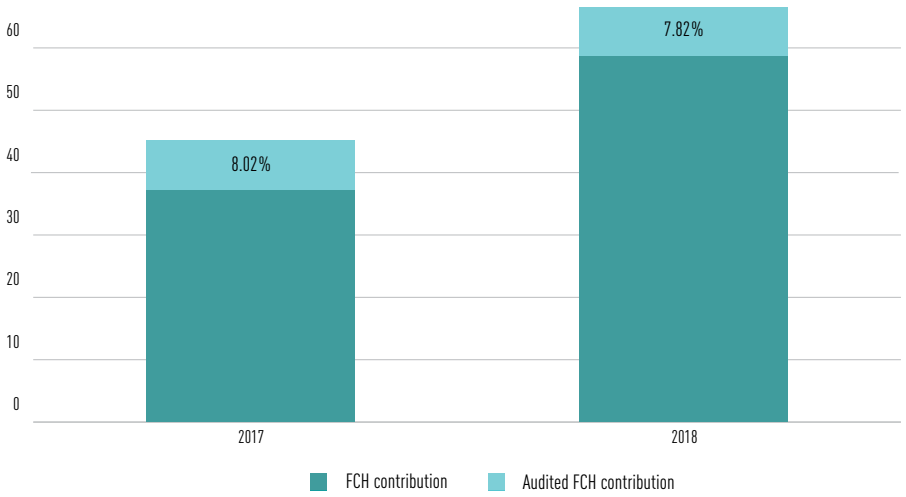
TOTAL (2017+2018)

COSTS			FCH 2 JU CONTRIBUTION			NO OF PARTICIPATIONS
ACCEPTED BY FCH 2 JU	COVERED VIA AUDITS LAUNCHED	PERCENTAGE	ACCEPTED BY FCH 2 JU	COVERED VIA AUDITS LAUNCHED	PERCENTAGE	
126.24	22.59	17.89 %	95.74	15.85	16.55 %	39

Graph 4.3.1: Audit coverage of accepted costs (2017-2018)



Graph 4.3.2: Audit coverage of accepted FCH contribution (2017-2018)



Representative audits were selected following a common JU sampling methodology. The methodology[137] is built on the principles of stratified random sampling (which is similar to the method used by the FCH 2 JU in FP7) with the following objectives:

- Efficient use of resources
- Focusing on large-value cost claims
- Providing an overview of the full range of projects and beneficiaries in the FCH 2 JU programme
- Ensuring representability of the results, as per the International Standards on Auditing.

Out of 28 audits launched in 2017 and 2018, there were 11 audits (of 12 participations) closed as at 31 December 2018.

FCH 2 JU specific error rates for H2020

The **overall detected error rate** is calculated based on all closed participations from 11 audits with net results combining both positive and negative, either from representative or corrective audits.

As of 31 December 2018 the **overall detected error rate was –1.84 %**.

Results of six representative closed audits out of 11 were used to calculate **an indicative representative error rate on H2020 expenditure specific to the FCH 2 JU.**

The methodology of the representative error rate calculation was the same as in FP7 programme (simple average).

For the residual error rate calculation, the FCH 2 JU approach is in line with the CAS approach (see above).

The input for the formulae in terms of P, E and A figures were provided by CAS, including the data for all FCH 2 JU participations in the audited spectrum of the beneficiaries either by FCH 2 JU or by other R&I services, ensuring the maximum cleaning effect of the residual error rate on the FCH 2 JU contribution.

The input for the representative error rate and systematic part of the error rate was derived from the results of FCH 2 JU-specific representative audits closed by 31 December 2018.

The results of the representative and residual error rate specific to FCH 2 JU are:

Representative error rate on costs	-1.24 %
Representative error rate on FCH 2 JU contribution	-0.5 %
Residual error rate on FCH 2 JU contribution	**–0.46 %**

Conclusions

Cumulative FP7 error rates show a stable but declining trend, especially in residual error rates, which are constantly below 2 %, providing a robust indicator of the legality and regularity of the underlying transactions.

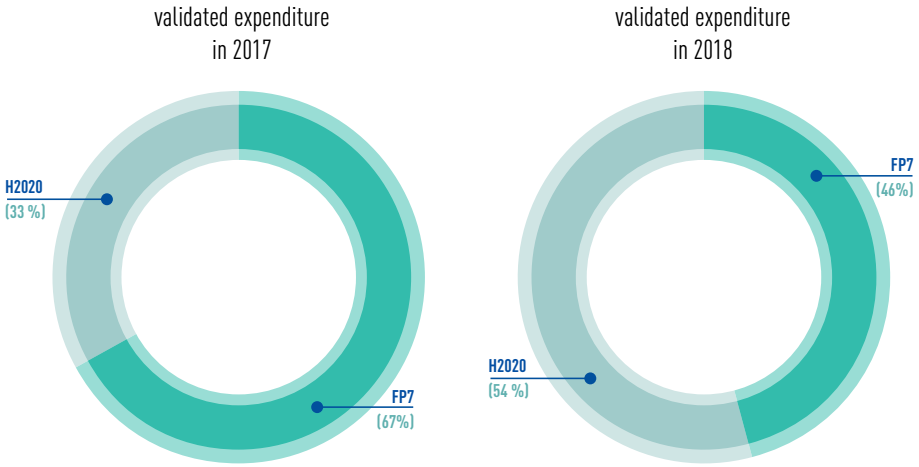
For the H2020 programme, sufficient audit coverage was ensured via the selection of the *ex-post* audits in 2017 and in 2018.

The years 2018 and 2019 are expected to be the last two years that FCH 2 JU launched FP7 *ex-post* audits because of the decreasing amount of FP7 expenditure validated vs. H2020 expenditure validated.

137 Endorsement of the methodology by the CSC executive committee is planned for 2019.

To support this observation, the graph below shows a trend observed in the previous two years, where H2020 validated expenditure slowly outweighed FP7 expenditure. In the year 2019, we expect the trend to continue, with H2020 expenditure most likely representing more than 80 % of yearly validated expenditure.

Graph 4.3.3: FP7 and H2020 validated expenditure in 2017 and 2018



The preliminary audit results from H2020 point to a downward trend for the error rates in H2020, mostly thanks to the simplification of the lump sum of 25 % applicable for indirect costs (as compared to the FP7 programme, where the most common errors were found in the calculation of indirect costs).

The positive trend in the error rates under H2020 can only be confirmed once more audit results become available.

As part of an internal control, all lessons learnt and observations from the *ex-post* audits (applicable for both the FP7 and H2020 programmes) feed back into the system of *ex-ante* checks in order to improve their effectiveness and efficiency.

This is an ongoing process, where close cooperation between FCH 2 JU operational units is facilitating the achievement of synergies between technical and financial knowledge, applied in practice.

4.4 AUDIT OF THE EUROPEAN COURT OF AUDITORS

In 2018, the FCH 2 JU:

- Continued its cooperation with an independent auditor to audit FCH 2 JU accounts, as required by the FCH 2 JU financial rules
- Provided support for the ECA auditors in the framework of their audit on the 2017 accounts
- Followed up and implemented the recommendations made in the European Court of Auditors reports on the FCH 2 JU annual accounts.

4.5 INTERNAL AUDIT

The internal audit is carried out according to Article 20 of the financial rules of the FCH 2 JU.

Based on Council Regulation (EU) No 559/2014 of 6 May 2014 establishing the FCH 2 JU, the internal audit operation is under the authority and responsibility of the EC's Internal Audit Service (IAS), succeeding the previous role taken on by the FCH 2 JU's Internal Audit Capability (IAC).

Within the FCH 2 JU, a new role as internal control and audit manager was established in 2015 to act as a main contact point for IAS and coordinate the execution and follow-up of the annual internal audits carried out by the IAS.

In 2018, the FCH 2 JU finalised implementation of all action plans addressing recommendations on the IAS audit on the FCH 2 JU's performance management undertaken by the IAS in 2016, including a recommendation on revision of the MAWP and linking of the strategic and operational objectives.

On 15 January 2018, the FCH 2 JU submitted an action plan to the IAS for three recommendations raised by the IAS regarding coordination with the CSC and implementation of CSC tools and services in the FCH 2 JU (new IAS audit finalised in December 2017).

On 12 June 2018, as a part of the action plan (which was prepared jointly in cooperation with the CSC), the FCH 2 JU organised its first workshop with the CSC. The objective of the workshop was to present the mission and tasks of each individual unit of the CSC (presented by their heads of units) and ways of cooperation with individual JUs.

The workshop was attended by more than 100 people from all the JUs and it was chaired by the Director of the CSC, Ms Anna Panagopoulou. The closing remarks were presented by the Director-General of DG RTD, Mr Jean-Eric Paquet, who highlighted the future Horizon Europe programme.

In December 2018, the FCH 2 JU submitted all action plans from the recommendations of the 2017 audit report to the IAS for a review. In January 2019, the IAS sent a letter to the FCH 2 JU Governing Board confirming that all the recommendations and action plans had been successfully implemented.

In October 2018, the IAS undertook a risk assessment at the premises of the FCH 2 JU in order to obtain input for their new Strategic Internal Audit Plan for 2019-2021. The IAS' draft report on the result of this risk assessment was still not available when this FCH 2 JU AAR was being finalised (February 2019).

4.6 RISK MANAGEMENT AND CONFLICT OF INTEREST

Risk management

During the annual risk assessment workshop, held in October 2018, the FCH 2 JU team reflected on the status of the significant risks and action plans that had been identified in the previous year and assessed their adequacy and relevance for 2019.

In addition, consolidated input was gathered and discussed in order to establish a list of new significant risks for 2019, and the respective action plans were drawn up.

The full list of important risks and related action plans identified can be found in the AWP 2019.

A complete risk matrix for 2019 (including risks of lower priority) is assessed and discussed within management regularly, as part of an ongoing risk assessment process, to reflect on any changes in the organisation's internal and external environment. This exercise, part of the internal control system, is designed to capture, in a timely way, any new and emerging risks that could potentially influence the achievement of the FCH 2 JU's objectives, as well as to provide timely reflection on the rating and relevance of the existing risks to ensure that appropriate actions and mitigating measures are put in place.

The FCH 2 JU will report on the fulfilment of the action plans and relevance of these risks in the 2019 AAR.

4.7 COMPLIANCE AND EFFECTIVENESS OF INTERNAL CONTROL

Priority is given to implementing and maintaining an effective internal control system so that reasonable assurance can be given that:

- Resources assigned to the activities are used according to the principles of sound financial management;
- The control procedures in place give the necessary guarantees concerning the legality and regularity of transactions.

In line with the objectives and priorities described in the AWP 2018, the robustness of the internal control system was monitored throughout the year. Internal control topics were also regularly discussed during weekly management and unit meetings or ad-hoc meetings (when preparing new processes or revising existing operating procedures). Risks identified through the annual risk assessment exercise (see Sections 1.1 and 4.6), which might pose a threat to achievement of FCH 2 JU's mission and objectives, were also systematically assessed and managed through appropriate controlling and mitigating actions.

Throughout the year, particular efforts were made to monitor KPIs. The time to pay, time to grant and budget execution were closely followed, which led to maintaining the efficiency shown in 2017.

Following the adoption of the revised Internal Control Framework, the FCH 2 JU carried out a detailed exercise on the assessment of internal controls, taking into account the above elements. In conclusion, it can be confirmed that the FCH 2 JU is in compliance with all the principles, the controls in place are working as intended, and the internal control system is providing an effective framework for managing any risks to the JU's ability to achieve its objectives.

05
MANAGEMENT ASSURANCE

5.1 ASSESSMENT OF THE ANNUAL ACTIVITY REPORT BY THE GOVERNING BOARD

This section will be provided separately.

5.2 ELEMENTS SUPPORTING ASSURANCE

Reasonable assurance is the personal judgement of the JU's Executive Director – as the JU's authorising officer at the date of signature of this Annual Activity Report – based on all the information at his disposal.

The main elements supporting the assurance are based on the JU's management assessment of the robustness of the JU's Internal Control Framework, the results of audits from the ECA and the IAS, the reporting from the internal control and audit manager, and the reporting from the heads of unit.

No significant weaknesses were identified or reported under Section 2 ('Support to Operations') and Section 4 ('Internal Control Framework'). Furthermore, based on their review, the heads of unit consider that given the scope of the statement of assurance and taking into account the controls and monitoring system in place, there are no weaknesses that could call into question the reasonable assurance as to the use of resources for their intended purpose, in accordance with the principles of sound financial management, and the fact that the implemented control procedures provide the necessary guarantees on the legality and regularity of the underlying transactions.

5.3 RESERVATIONS

FP7 programme

The **representative error rate** resulting from the 111 representative audits finalised is **–2.64%** (2017: -2.73%) at the total cost level and **–2.09%** (2017: -2.14%) at the FCH 2 JU contribution level.

The **residual error rate** (i.e. error remaining in the population after corrections and recoveries) calculated at this point is **–1.15%** (2017: -1.13%) at total cost level and **–1.10%** (2017: -1.09%) at FCH 2 JU contribution level. This rate should develop as more audits are closed and more corrections and recoveries undertaken.

H2020 programme

The indicative **representative error rate** resulting from the seven representative audits finalised is **–1.24%** at total cost level and **–0.50%** at FCH 2 JU contribution level.

The residual error rate (i.e. error remaining in the population after corrections and recoveries) calculated at this point is **–0.46%** at FCH 2 JU contribution level. This rate should develop as more audits are closed and more corrections and recoveries undertaken.

Taking into consideration:

- The residual error rates below 2 % at this point in time
- The adequate audit coverage, comprising a representative number of finalised audits
- The experience gained by JU staff in the *ex-ante* validation of costs claims
- The JU's strong *ex-ante* controls (financial webinars, etc.)

no reservation is necessary. In the opinion of the Executive Director, considering the aspects above and with the information available at this stage, it is possible to state with reasonable assurance that by the end of the programme the residual error rate will be below the materiality threshold (i.e. 2 %) established in Annex 9 ('Materiality criteria').

FCH 2 JU actions towards an acceptable level of 'residual error rate'

The declaration of assurance in 2017 did not include a reservation, as is the case this year (2018). This is the result of the FCH 2 JU's firm commitment to maintain a robust internal control system where *ex-post* audits play a significant role. The 'residual error rate' is a key indicator of the legality and regularity of the JU's transactions. In this context, in 2012, the FCH 2 JU set out an action plan with the aim of achieving an acceptable level of residual error rate, which should provide sufficient assurances to the Executive Director, while at the same time respecting cost-benefit principles (i.e. the cost of controls have to be measured against the benefits that those additional controls can bring to the organisation – auditing 100 % of the cost claims is not cost-efficient).

The FCH 2 JU action plan includes a combination of **preventive, detective and corrective measures** and is closely monitored. The measures/actions can be grouped around three main axes as follows:

For FP7

- Organisation of **communication campaigns** to prevent financial errors in cost reporting by improving awareness among the beneficiaries of the regulatory framework. In total, seven campaigns were organised by the FCH 2 JU (three in 2012, two in 2013, one in 2014 and one in 2015). The campaign set-up was reviewed in 2013 to maximise its impact, with the possibility of participating on-site or online, a targeted audience (including auditors responsible for the preparation of the CFS and *ex-post* auditors) and a focus on the most recurrent issues. The 2015 campaign continued with on-site and online participation, with particular emphasis on the eligibility aspects in 'demonstration' projects. In total, 146 beneficiaries involved in 129 projects attended the communication campaigns. This represents approximately 27 % and 83 % of FCH 2 JU beneficiaries and projects, respectively. The communication campaigns were highly appreciated by the participants and their positive impact has been visible since 2013, through an improvement in the quality of beneficiaries' cost reporting.
- Maintaining strong FCH 2 JU ***ex-ante* controls** to enable greater detection and correction of errors before validating cost claims (e.g. JU's scrutiny of the CFS, and its thorough *ex-ante* checklists).
- Continuation of the FCH 2 JU *ex-post* audit efforts. As of 31 December 2018, 141 audits were launched for FCH-FP7 grants, of which 132 were finalised and the remaining are expected to be finalised in the first quarter of 2019, representing a cumulative audit coverage of 23 % of the value of validated cost claims and 24 % in terms of the number of beneficiaries. The combination of appropriate audit coverage and a relatively low detected error rate has resulted in a residual error rate below 2 %.

The positive feedback loop generated by the combination of the three actions above is of particular importance. For example, the (preventive) communication campaigns provided a very useful platform on which to share experiences between beneficiaries and JU actors. Also, *ex-post* audits have a multiplying effect: lessons learned from the results of *ex-post* audits provide very valuable information not only for the audited beneficiary, but also for the JU's *ex-ante* controllers for future cost claims and other beneficiaries of the same project.

For H2020

- Organisation of financial workshops to explain key aspects of the financial provisions of the H2020 Model Grant Agreement and of financial reporting with a focus on specificities and business models pertinent for the FCH 2 JU and aiming to prevent errors. After the first workshop in 2016, a second one was organised in March 2017 (see also Section 4.2).

- Increased involvement of financial officers at the grant agreement preparation and in project kick-off meetings in order to check financial aspects and clarify financial reporting requirements.

- Ad-hoc financial webinars for individual projects, depending on the complexity of the project and need of the beneficiaries.

- *Ex-ante* controls consistent with the guidelines on *ex-ante* controls in H2020, adopted by the CSC, which are predominantly risk-based and/or justified by deviations from the budget.

- *Ex-post* audits: as indicated in the sections on H2020 *ex-post* audits above, the FCH 2 JU will ensure that, in line with Annex 1 to the H2020 Audit Strategy, the audit effort is sufficient to allow for an adequate coverage and the calculation on a representative error rate on FCH 2 JU expenditure.

The FCH 2 JU has a clear control strategy which is multi-annual in nature and combines *ex-ante* and *ex-post* controls, and takes cost-efficiency into consideration. Since this strategy has proved its effectiveness from an assurance point of view, the FCH 2 JU is fully committed to continuing its work along the same control principles.

5.4 OVERALL CONCLUSIONS

The purpose of this section is to provide an overall conclusion on the declaration of assurance as a whole (Section 6).

It is important to note that only material weaknesses/risks lead to a reservation concerning the assurance in Section 6. The concept of 'materiality' provides the Executive Director with a basis for assessing the importance of the weaknesses/risks identified. Deciding whether something is material involves making a judgement in both qualitative and quantitative terms (see details on the 'Materiality criteria' in Annex 9).

Based on the information provided in the sections above, the following conclusions can be drawn.

- Concerning the FCH 2 JU's policy activities, no qualification is to be made. Likewise, there is no reservation in the procedures relating to the selection of contractors and beneficiaries for FCH 2 JU projects and their underlying financial operations (legal and financial commitments). This is also the case for JU's payments relating to administrative expenditure and procurement, as well as for pre-financing payments in the case of grants.

- The amounts with a greater risk of being affected by errors are the expenditure incurred against cost statements. Based on the analysis of error rates and the effectiveness of the preventive, detective and corrective actions presented in Section 5.3, no reservation is necessary in this area either.

In conclusion, the JU's management has reasonable assurance that, overall, suitable controls are in place and working as intended, risks are being properly monitored and mitigated, and necessary improvements noted by the auditors (i.e. European Commission's IAS and the ECA) are being implemented. Therefore, the Executive Director, in his capacity as authorising officer, has signed the declaration of assurance presented in Section 6.

06
DECLARATION OF ASSURANCE

I, the undersigned, Bart Biebuyck

Executive Director of the FCH 2 JU

In my capacity as authorising officer by delegation

Declare that the information contained in this report gives a true and fair view[138].

State that I have reasonable assurance that the resources assigned to the activities described in this report have been used for their intended purpose and in accordance with the principles of sound financial management, and that the control procedures put in place give the necessary guarantees concerning the legality and regularity of the underlying transactions.

This reasonable assurance is based on my own judgement and on the information at my disposal, such as the results of the self-assessment, *ex-post* controls, the work of the internal audit capability, the observations of the Internal Audit Service and the lessons learnt from the Court of Auditors' reports for the years prior to the year of this declaration.

Confirm that I am not aware of anything not reported here which could harm the interests of the Joint Undertaking.

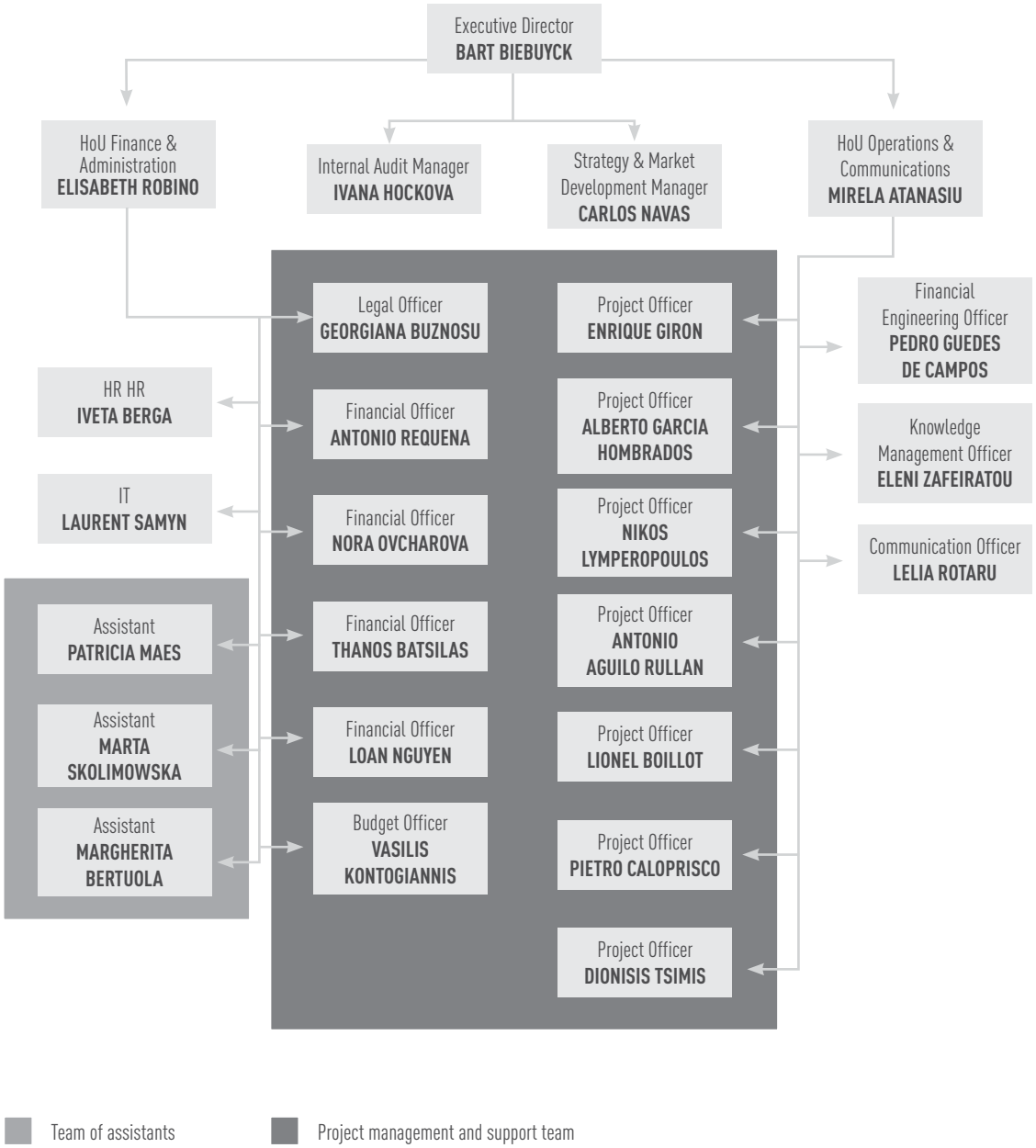
Brussels, 28 February 2019

Bart Biebuyck
Executive Director FCH 2 JU

138 True and fair in this context means a reliable, complete and correct view on the state of affairs in the Joint Undertaking.

07
ANNEXES

ANNEX 1
Organisation chart



ANNEX 2
Staff establishment plan

The JU team of statutory staff consists of 27 members (24 temporary agents and 3 contract agents). In addition, staff resources include two Seconded National Experts (SNE).

The 2017-2018 Staff establishment plan is shown below.

GRADE	2017 AMENDED	2017 FILLED	2018 BUDGET	2018 FILLED
AD 16	-	-	-	-
AD 15	-	-	-	-
AD 14	1	1	1	1
AD 13	-	-	-	-
AD 12	-	-	-	-
AD 11	2	2	2	2
AD 10	-	-	-	-
AD 9	2	2	2	2
AD 8	6	6	6	6
AD 7	-	-	-	-
AD 6	1	1	3	3
AD 5	3	3	1	1
Total AD[139]	**15**	**15**	**15**	**15**
AST 11	-	-	-	-
AST 10	-	-	-	-
AST 9	-	-	-	-
AST 8	2	2	2	2
AST 7	1	1	1	1
AST 6	1	1	1	1
AST 5	-	-	1	1
AST 4	3	4	4	4
AST 3	2	1	-	-
AST 2	-	-	-	-
AST 1	-	-	-	-
Total AST[140]	**9**	**9**	**9**	**9**
Function Group IV	1	1	1	1
Function Group III	1	1	1	1
Function Group II	-	-	1	1
Function Group I	-	-	-	-
Total contract agents	**2**	**2**	**3**	**3**
Total Seconded National Experts	**2**	**0**	**2**	**0**

139 AD stands for administrator.

140 AST stands for assistant.

ANNEX 3

Publications from projects

The list of publications related to both FP7 and H2020, projects is given below[142]:

Project number	Project acronym	Publication title	Authors
303411	Don Quichote	A Step Towards the Hydrogen Economy – A Life Cycle Cost Analysis of a Hydrogen Refuelling Station	Ludvik Viktorsson (INE), Jukka Taneli Heinonen, Jon Bjorn Skulason (INE), Runar Unnthorsson
303411	Don Quichote	Feasibility study of large scale hydrogen applications and cost of the systems evolving with scaling up	S. Weidner, Dr. M, Faltenbacher (thinkstep AG), I. François (Waterstofnet), D. Thomas (Hydrogenic), J. B. Skùlason (INE), C. Maggi (FAST)
303429	Evolve	Evaluation of Performance and Degradation Profiles of a Metal Supported Solid Oxide Fuel Cell under Electrolysis Operation	Aziz Nechache, Feng Han, Robert Semerad, Guenter Schiller, Rémi Costa
303429	Evolve	On the manufacturing of low temperature activated Sr0.9La 0.1Ti03-δ-Ce1-xGdx02-δ anodes for solid oxide fuel cell	Angela Gondolini, Elisa Mercadelli, Guillaume Constantin, Laurent Dessemond, Vitaliy Yurkiv, Rémi Costa, Alessandra Sanson
303429	Evolve	Performances and Limitations of Metal Supported Cells with Strontium Titanate based Fuel Electrode	R.Costa, F. Han, P. Szabo, V. Yurkiv, R. Semerad, S.K. Cheah, L. Dessemond
325278	PROSOFC	Development of a Segmented Single SOFC Test Equipment to Simulate Stack-Like Operating Conditions	Martin Hauth, Daniel Schaffer, Nikolaus Soukup, Alexandre Gitz, Clement Dufour, Michael Rachinger, Clemens Fink
325278	PROSOFC	Production and Reliability Oriented SOFC Cell and Stack Design	Martin Hauth, Vincent Lawlor, Peter Cartellieri, Christopher Zechmeister, Sebastian Wolff, Christian Bucher, Jürgen Malzbender, Jianping Wei
325278	PROSOFC	Steady state creep of Ni-8YSZ substrates for application in solid oxide fuel and electrolysis cells	J. Wei, J. Malzbender
325278	PROSOFC	Transient deformational properties of high temperature alloys used in solid oxide fuel cell stacks	Tesfaye Tadesse Molla, Kawai Kwok, Henrik Lund Frandsen
325325	ONSITE	Dynamic simulation of a multi-generation system, for electric and cooling energy provision, employing a SOFC cogenerator and an adsorption chiller	Valeria Palomba, Marco Ferraro, Andrea Frazzica, Salvatore Vasta, Francesco Sergi, Vincenzo Antonucci
325325	ONSITE	Experimental and numerical analysis of a SOFC-CHP system with adsorption and hybrid chillers for telecommunication applications	Valeria Palomba, Marco Ferraro, Andrea Frazzica, Salvatore Vasta, Francesco Sergi, Vincenzo Antonucci
325325	ONSITE	Modelling of a SOFC-HT battery hybrid system for optimal design of off-grid base transceiver station	G. Brunaccini, F. Sergi, D. Aloisio, M. Ferraro, M. Blesznowski, J. Kupecki, K. Motylinski, V. Antonucci
325331	SCoReD 2:0	Composite Cu-LaFeO3 Coating on High Cr Ferritic Stainless Steels for IT-SOFC Interconnects	Andrea Masi, Stefano Frangini, Livia Della Seta, Stephen J. McPhail, Davide Pumiglia, Maurizio Carlini
325331	SCoReD 2:0	Composite Cu-LaFeO3 Conversion Coatings on a 18Cr Ferritic Stainless Steel for IT-SOFC Interconnects: An Investigation on Structure and Formation Mechanism	A. Masi, S. Frangini, L. Della Seta, S. J. McPhail, M. Carlini
325331	SCoReD 2:0	Cu-Mn-Co oxides as protective materials in SOFC technology: The effect of chemical composition on mechanochemical synthesis, sintering behaviour, thermal expansion and electrical conductivity	Andrea Masi, Mariangela Bellusci, Stephen J. McPhail, Franco Padella, Priscilla Reale, Jong-Eun Hong, Robert Steinberger-Wilckens, Maurizio Car
325331	SCoReD 2:0	LaFeO3 perovskite conversion coatings grown on a 13Cr ferritic stainless steel: a corrosion degradation study in simulated solid oxide fuel cell (SOFC) interconnect conditions at 700 °C	A. Masi, S. Frangini, D. Pumiglia, L. Della Seta, A. Masci, S. J. McPhail, M. Carlini

141 The table has been devised from the publications query in CORDA databases for H2020 and FP7 projects. As part of the TRUST annual exercise collecting data from the year-minus 1, the list contains publications covering both 2017 and 2018. For the full list of previous publications, please refer to the Annual Activity Report 2016.

142 Publication frequency is applicable to FP7 projects, and the ISSN (International Standard Serial Number) to H2020 projects

143 Open Access includes both Green and Gold

Journal title	Relevant pages	ISSN/Publication frequency[142]	Publisher	Publication year	Open Access[143]
Energies	.763	Vol.10	Molecular Diversity Preservation International	2017	YES
International Journal of Hydrogen Energy	15625-15638	Vol 43./Issue 33	Elsevier Limited	2017	YES
ECS Transactions	3039-3047	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
Journal of the European Ceramic Society	In press	In press	Elsevier BV	2017	NO
Fuel Cells	Submitted	Submitted	John Wiley and Sons Ltd	2017	NO
ECS Transactions	2115-2132	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
ECS Transactions	2231-2249	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
Journal of Power Sources	-	-	Elsevier	2017	NO
Journal of Power Sources	8-16	Vol. 351	Elsevier	2017	NO
Energy Procedia	416-423	Vol. 143	Elsevier BV	2017	NO
Applied Energy	620-633	Vol. 216	Elsevier BV	2018	NO
International Journal of Hydrogen Energy	27962-27978	Vol. 42/Issue 46	Elsevier Limited	2017	NO
ECS Transactions	77-86	Vol. 75/Issue 27	The Electrochemical Society	2017	NO
Journal of the Electrochemical Society	F850-F857	Vol. 164/Issue 7	Electrochemical Society, Inc.	2017	YES
Journal of the European Ceramic Society	661-669	Vol. 37/Issue 2	Elsevier BV	2017	NO
Materials and Corrosion – Werkstoffe und Korrosion	536-545	Vol. 68/Issue 5	John Wiley and Sons Ltd	2017	NO

Project number	Project acronym	Publication title	Authors
325331	SCoReD 2:0	Modelling Microstructural and Chemical Degradation of Ferritic Stainless Steels for SOFC Interconnects	M.Oum, J.Andrews, R.Steinberger-Wilckens
325331	SCoReD 2:0	The effect of chemical composition on high temperature behaviour of Fe and Cu doped Mn-Co spinels	Andrea Masi, Mariangela Bellusci, Stephen J. McPhail, Franco Padella, Priscilla Reale, Jong-Eun Hong, Robert Steinberger-Wilckens, Maurizio Car
325335	Auto-Stack CORE	Characteristic Time Constants Derived from the Low Frequency Arc of Impedance Spectra of Fuel Cell Stacks	Stefan Keller, Tansu Özel, Anne-Christine Scherzer, Dietmar Gerteisen, Ulf Groos, Christopher Hebling, Yiannos Manoli
325356	POWER-UP	In-operando optical observations of alkaline fuel cell electrode surfaces during harsh cycling tests	Richard Dawson, Anant Patel, Kolade Alako, Samritha Parhar, Christopher Hinde, Christopher Reynolds
325361	HYDROSOL-PLANT	On kinetic modelling for solar redox thermochemical H2O and CO2 splitting over NiFe2O4 for H2, CO and syngas production	Dimitrios A. Dimitrakis, Maria Syrigou, Souzana Lorentzou, Margaritis Kostoglou, Athanasios G. Konstandopoulos
325361	HYDROSOL-PLANT	Thermochemical cycles over redox structured reactors	S. Lorentzou, C. Pagkoura, A. Zygogianni, G. Karagiannakis, A.G. Konstandopoulos
325361	HYDROSOL-PLANT	Thermochemical H2O and CO2 splitting redox cycles in a NiFe2O4 structured redox reactor: Design, development and experiments in a high flux solar simulator	S. Lorentzou, D. Dimitrakis, A. Zygogianni, G. Karagiannakis, A.G. Konstandopoulos
325383	BioRobur	Biogas robust processing with combined catalytic reformer and trap. Part 1: Catalysts and Support Design	All BioRobur Partners
325383	BioRobur	Biogas robust processing with combined catalytic reformer and trap. Part 2: Tests on Demonstration Plant	All BioRobur Partners
325383	BioRobur	Deactivation mechanism of Ni supported on Mg-Al spinel during autothermal reforming of model biogas	Mathilde Luneau, Elia Gianotti, Frédéric C. Meunier, Claude Mirodatos, Eric Puzenat, Yves Schuurman, Nolven Guilhaume
325383	BioRobur	Early-stage oxidation behaviour at high temperatures of SiSiC cellular architectures in a porous burner	A. Ortona
325383	BioRobur	LCA evaluation for the hydrogen production through the innovative BioRobur project concept	S. Pris Hernandez Ribullon, F.Battista, S.Bensaid, B. Ruggeri, D. Fino
325383	BioRobur	Techno-economic analysis of green hydrogen production from biogas autothermal reforming	All BioRobur Partners
621173	SOPHIA	A 2D and 3D X-ray µ-diffraction and µ-fluorescence study of a mixed ionic electronic conductor	Dario Ferreira Sanchez, Daniel Grolimund, Maxime Hubert, Pierre Bleuet, Jérôme Laurencin
621173	SOPHIA	Degradation mechanism of La0.6Sr0.4Co0.2Fe0.8O3 δ/ Gd0.1Ce0.9O2-δ composite electrode operated under solid oxide electrolysis and fuel cell conditions	J. Laurencin, M. Hubert, D. Ferreira Sanchez, S. Pylypko, M. Morales, A. Morata, B. Morel, D. Montinaro, F. Lefebvre-Joud, E. Siebert
621173	SOPHIA	Effects of Pressure on High Temperature Steam and Carbon Dioxide Co-electrolysis	L.Bernadet, J.Laurencin, G.Roux, D.Montinaro, F.Mauvy, M.Reytier
621173	SOPHIA	Evaluation of a SOE Stack for Hydrogen and Syngas Production: a Performance and Durability Analysis	M. Kotisaari, O. Thomann, D. Montinaro, J. Kiviaho
621173	SOPHIA	Evolution of 3-D Transport Pathways and Triple-Phase Boundaries in the Ni-YSZ Hydrogen Electrode upon Fuel Cell or Electrolysis Cell Operation	Arata Nakajo, Alex P. Cocco, M. B. DeGostin, Pierre Burdet, Aldo A. Peracchio, Brice N. Cassenti, Marco Cantoni, Jan Van herle, Chiu Wilson K. S.
621173	SOPHIA	Hydrogen production by coupling pressurized high temperature electrolyser with solar tower technology	N. Monnerie, H. von Storch, A. Houaijia, M. Roeb, C. Sattler
621173	SOPHIA	Optimal design of solid-oxide electrolyser based power-to-methane systems: A comprehensive comparison between steam electrolysis and co-electrolysis	Ligang Wang, Mar Pérez-Fortes, Hossein Madi, Stefan Diethelm, Jan Van herle, François Maréchal
621173	SOPHIA	Solid Oxide Cell Degradation Operated in Fuel Cell and Electrolysis Modes: A Comparative Study on Ni Agglomeration and LSCF Destabilization	Maxime Hubert, Jérôme Laurencin, Peter Cloetens, Julie Mougin, Dario Ferreira Sanchez, Sergii Pylypko, Miguel Morales, Alex Morata, Bertrand Morel, Dario Montinaro, Elisabeth Siebert and Florence Lefebvre-Joud
621173	SOPHIA	Strontium Migration at the GDC-YSZ Interface of Solid Oxide Cells in SOFC and SOEC Modes	Giorgio Rinaldi, Arata Nakajo, Jan Van herle, Pierre Burdet, Emad Oveisi, Marco Cantoni
621181	FERRET	Achievements of European projects on membrane reactor for hydrogen production	Gioele Di Marcoberardino, Marco Binotti, Giampaolo Manzolini, José Luis Viviente, Alba Arratibel, Leonardo Roses, Fausto Gallucci
621181	FERRET	Investigation of a 5 kW micro-CHP PEM fuel cell based system integrated with membrane reactor under diverse EU natural gas quality	G. Di Marcoberardino, G. Manzolini

Journal title	Relevant pages	ISSN/Publication frequency[142]	Publisher	Publication year	Open Access[143]
ECS Transactions	1565-1574	78	The Electrochemical Society	2017	NO
Ceramics International	2829-2835	Vol. 43/Issue 2	Elsevier Limited	2017	NO
Journal of Fuel Cell Science and Technology	1-38	Vol. 15	American Society of Mechanical Engineers (ASME)	2018	NO
International Journal of Hydrogen Energy	21203-21214	Vol. 42/Issue 33	Elsevier Limited	2017	YES
Physical Chemistry Chemical Physics	26776-26786	Vol. 19/Issue 39	Royal Society of Chemistry	2017	YES
International Journal of Hydrogen Energy	19664-19682	Vol. 42/Issue 31	Elsevier Limited	2017	YES
Solar Energy	1462-1481	Vol. 155	Elsevier Limited	2017	YES
International Journal of Hydrogen Energy	*	Catalysts and Support Design	Elsevier Limited	2017	YES
International Journal of Hydrogen Energy	*	Tests on Demonstration Plant	Elsevier Limited	2017	YES
Applied Catalysis B: Environmental	289-299	Vol. 203	Elsevier	2017	NO
Ceramics International	CERI-D-16-03767R2	Ceramics	Elsevier Limited	2017	NO
International Journal of Hydrogen Energy	Manuscript No HE-D-16-01536	WHEC2016	Elsevier Limited	2017	NO
Clean Technologies and Environmental Policy	CTEP-S-16-00757-2	Green hydrogen production from biogas autothermal reforming	Springer Verlag	2017	YES
International Journal of Hydrogen Energy	1203-1211	Vol. 42/Issue 2	Elsevier Limited	2017	NO
Electrochimica Acta	459-476	Vol. 241	Elsevier Limited	2017	NO
Electrochimica Acta	114-127	253	Elsevier Limited	2017	NO
Fuel Cells	571-580	Vol. 17/Issue 4	John Wiley and Sons Ltd	2017	NO
ECS Transactions	3205-3215	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
International Journal of Hydrogen Energy	13498-13509	Vol. 42/Issue 19	Elsevier Limited	2017	NO
Applied Energy	1060-1079	Vol. 211	Elsevier BV	2018	NO
ECS Transactions	3167-3177	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
ECS Transactions	3297-3307	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
Journal of Cleaner Production	1442-1450	Vol. 161	Elsevier Limited	2017	YES
International Journal of Hydrogen Energy	13988-14002	Vol. 42/Issue 19	Elsevier Limited	2017	NO

Project number	Project acronym	Publication title	Authors
621181	FERRET	Palladium based membranes and membrane reactors for hydrogen production and purification: An overview of research activities at Tecnalia and TU/e	E. Fernandez, A. Helmi, J.A. Medrano, K. Coenen, A. Arratibel, J. Melendez, N.C.A. de Nooijer, V. Spallina, J.L. Viviente, J. Zuñiga, M. van Sint Annaland, D.A. Pacheco Tanaka, F. Gallucci
621181	FERRET	Recent Advances in Pd-Based Membranes for Membrane Reactors	Alba Arratibel Plazaola, David Pacheco Tanaka, Martin Van Sint Annaland, Fausto Gallucci
621196	FluidCELL	Achievements of European projects on membrane reactor for hydrogen production	Gioele Di Marcoberardino, Marco Binotti, Giampaolo Manzolini, José Luis Viviente, Alba Arratibel, Leonardo Roses, Fausto Gallucci
621196	FluidCELL	A comprehensive model of a fluidized bed membrane reactor for small-scale hydrogen production	S. Foresti, G. Di Marcoberardino, G. Manzolini, N. De Nooijer, F. Gallucci, M. van Sint Annaland
621196	FluidCELL	Advanced m-CHP fuel cell system based on a novel bio-ethanol fluidized bed membrane reformer	Jose Luis Viviente, Jon Meléndez, David Alfredo Pacheco Tanaka, Fausto Gallucci, Vincenzo Spallina, Giampaolo Manzolini, Stefano Foresti, Vincenzo Palma, Concetta Ruocco, Leonardo Roses
621196	FluidCELL	Direct route from ethanol to pure hydrogen through autothermal reforming in a membrane reactor: Experimental demonstration, reactor modelling and design	V. Spallina, G. Matturro, C. Ruocco, E. Meloni, V. Palma, E. Fernandez, J. Melendez, A.D. Pacheco Tanaka, J.L. Viviente Sole, M. van Sint Annland, F. Gallucci
621196	FluidCELL	Enhancing Pt-Ni/CeO_2 performances for ethanol reforming by catalyst supporting on high surface silica	Vincenzo Palma, Concetta Ruocco, Eugenio Meloni, Fausto Gallucci, Antonio Ricca
621196	FluidCELL	Experimental investigation of PEM fuel cells for a m-CHP system with membrane reformer	S. Foresti, G. Manzolini, S. Escribano
621196	FluidCELL	Highly active and stable Pt-Ni/CeO_2-SiO_2 catalysts for ethanol reforming	Vincenzo Palma, Concetta Ruocco, Eugenio Meloni, Antonio Ricca
621196	FluidCELL	Influence of Catalytic Formulation and Operative Conditions on Coke Deposition over CeO_2-SiO_2 Based Catalysts for Ethanol Reforming	Vincenzo Palma, Concetta Ruocco, Eugenio Meloni, Antonio Ricca
621196	FluidCELL	Optimization of PEM Fuel Cell Operation with High-purity Hydrogen Produced by a Membrane Reactor	S. Foresti, G. Manzolini
621196	FluidCELL	Oxidative steam reforming of ethanol in a fluidized bed over CeO_2-SiO_2 supported catalysts: effect of catalytic formulation	Vincenzo Palma, Concetta Ruocco, Antonio Ricca
621196	FluidCELL	Oxidative steam reforming of ethanol on mesoporous silica supported PtNi/CeO_2 catalysts	Vincenzo Palma, Concetta Ruocco, Eugenio Meloni, Antonio Ricca
621196	FluidCELL	Palladium based membranes and membrane reactors for hydrogen production and purification: An overview of research activities at Tecnalia and TU/e	E. Fernandez, A. Helmi, J.A. Medrano, K. Coenen, A. Arratibel, J. Melendez, N.C.A. de Nooijer, V. Spallina, J.L. Viviente, J. Zuñiga, M. van Sint Annaland, D.A. Pacheco Tanaka, F. Gallucci
621196	FluidCELL	Preparation and characterization of ceramic supported ultra-thin (~1 μm) Pd-Ag membranes	Jon Melendez, Ekain Fernandez, Fausto Gallucci, Martin van Sint Annaland, P.L. Arias, David A. Pacheco Tanaka
621196	FluidCELL	Renewable Hydrogen from Ethanol Reforming over CeO_2-SiO_2 Based Catalysts	Vincenzo Palma, Concetta Ruocco, Eugenio Meloni, Antonio Ricca
621196	FluidCELL	Three-dimensional modelling of PEMFC with contaminated anode fuel	M. Abdollahzadeh, P. Ribeirinha, M. Boaventura, A. Mendes
621207	Endurance	Degradation mechanism of La0.6Sr0.4Co0.2Fe0.8O3 δ/ Gd0.1Ce0.9O2-δ composite electrode operated under solid oxide electrolysis and fuel cell conditions	J. Laurencin, M. Hubert, D. Ferreira Sanchez, S. Pylypko, M. Morales, A. Morata, B. Morel, D. Montinaro, F. Lefebvre-Joud, E. Siebert
621207	Endurance	Effect of YSZ Coatings as Diffusion Barrier between Glass Sealing and Steel	Roberto Spotorno, Elisa Fracchia, Guenter Schiller, Paolo Piccardo
621207	Endurance	Influence of Surface Finishing on High-Temperature Oxidation of AISI Type 444 Ferritic Stainless Steel Used in SOFC Stacks	Valeria Bongiorno, Paolo Piccardo, Simone Anelli, Roberto Spotorno
621207	Endurance	LaNi0.6Fe0.4O3 as Cathode Contacting Material: Effect on Anode Supported Cell Performances	Roberto Spotorno, Paolo Piccardo, Rémi Costa, Feng Han, Guenter Schiller
621207	Endurance	Multi-scale analysis of the diffusion barrier layer of gadolinia-doped ceria in a solid oxide fuel cell operated in a stack for 3000 h	M. Morales, V. Miguel-Pérez, A. Tarancón, A. Slodczyk, M. Torrell, B. Ballesteros, J.P. Ouweltjes, J.M. Bassat, D. Montinaro, A. Morata
621207	Endurance	Parametrical Coordinates and Microsamples to Investigate Real SOFCs in Operating Stacks	Paolo Piccardo, Roberto Spotorno, Jan Pieter Ouweltjes, Zdravko Stoynov, Daria Vladikova
621208	DIAMOND	A model-based diagnostic technique to enhance faults isolability in Solid Oxide Fuel Cell systems	Pierpaolo Polverino, Marco Sorrentino, Cesare Pianese
621208	DIAMOND	Online gas composition estimation in solid oxide fuel cell systems with anode off-gas recycle configuration	B. Dolenc, D. Vrečko, Đ. Juričić, A. Pohjoranta, C. Pianese

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International Journal of Hydrogen Energy	13763-13776	Vol. 42/Issue 19	Elsevier Limited	2017	NO
Molecules	51	Vol. 22/Issue 1	Molecular Diversity Preservation International	2017	YES
Journal of Cleaner Production	1442-1450	Vol. 161	Elsevier Limited	2017	NO
Chemical Engineering and Processing	136-144	Vol. 127	Elsevier	2018	NO
International Journal of Hydrogen Energy	13970-13987	Vol. 42/Issue 19	Elsevier Limited	2017	NO
Energy	666-681	Vol. 143	Elsevier Limited	2018	YES
Catalysis Today	175-188	Vol. 307	Elsevier	2018	NO
International Journal of Hydrogen Energy	25334-25350	Vol. 42/Issue 40	Elsevier Limited	2017	NO
Journal of Cleaner Production	263-272	Vol. 166	Elsevier Limited	2017	NO
Energies	1030	Vol. 10/Issue 7	Molecular Diversity Preservation International	2017	YES
Fuel Cells	335-346	Vol. 18/Issue 3	John Wiley and Sons Ltd	2018	NO
Renewable Energy	356-364	Vol. 125	Elsevier BV	2018	NO
International Journal of Hydrogen Energy	1598-1608	Vol. 42/Issue 3	Elsevier Limited	2017	NO
International Journal of Hydrogen Energy	13763-13776	Vol. 42/Issue 19	Elsevier Limited	2017	NO
Journal of Membranes Science	12-23	Vol. 528	Elsevier	2017	NO
Catalysts	226	Vol. 7/Issue 8	MDPI AG	2017	YES
Energy	939-959	Vol. 152	Elsevier Limited	2018	NO
Electrochimica Acta	459-476	241	Elsevier Limited	2017	NO
ECS Transactions	1749-1758	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
Acta Metallurgica Sinica (English Letters)	697-711	Vol. 30/Issue 8	Chinese Society for Metals	2017	YES
ECS Transactions	1689-1699	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
Journal of Power Sources	141-151	344	Elsevier	2017	NO
ECS Transactions	2087-2098	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
Applied Energy	1198-1214	Vol. 204	Elsevier BV	2017	NO
Journal of Power Sources	246-253	Vol. 343	Elsevier	2017	NO

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621208	DIAMOND	State of health estimation and remaining useful life prediction of solid oxide fuel cell stack	B. Dolenc, P. Boškoski, M. Stepančič, A. Pohjoranta, Đ. Juričić
621210	HELMETH	CO_2 methanation over Ni catalysts based on ternary and quaternary mixed oxide: A comparison and analysis of the structure-activity relationships	Chalachew Mebrahtu, Salvatore Abate, Siglinda Perathoner, Shiming Chen, Gabriele Centi
621210	HELMETH	Enhanced catalytic activity of Fe-promoted Ni over γ-Al2O3 nanosheets for CO_2 methanation	Chalachew Mebrahtu, Salvatore Abate, Shiming Chen, Andres Felipe Sierra Salazar, Siglinda Perathoner, Florian Krebs, Regina Palkovits, Gabriele Centi
621210	HELMETH	System Approach of a Pressurized High-Temperature Electrolysis	Joerg Brabandt, Oliver Posdziech
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621213	STAGE-SOFC	Development and Testing of Innovative SOFC System Prototype with Staged Stack Connection for Efficient Stationary Power and Heat Generation	John Bachmann, Oliver Posdziech, Paulina Pianko-Oprych, Noora Kaisalo, Jari Pennanen
621213	STAGE-SOFC	Dynamic Analysis of Load Operations of Two-Stage SOFC Stacks Power Generation System	P. Pianko-Oprych, M. Hosseini
621213	STAGE-SOFC	Numerical investigation of a novel burner to combust anode exhaust gases of SOFC stacks	Paulina Pianko-Oprych, Zdzisław Jaworski
621213	STAGE-SOFC	On nanotube carbon deposition at equilibrium in catalytic partial oxidation of selected hydrocarbon fuels	Zdzisław Jaworski, Paulina Pianko-Oprych
621213	STAGE-SOFC	On thermodynamic equilibrium of carbon deposition from gaseous C-H-O mixtures: updating for nanotubes	Zdzisław Jaworski, Barbara Zakrzewska, Paulina Pianko-Oprych
621213	STAGE-SOFC	Simulation of SOFCs based power generation using Aspen	P. Pianko-Oprych, M. Palus
621216	SECOND ACT	Air Starvation Induced Degradation in Polymer Electrolyte Fuel Cells	M. Bodner, A. Schenk, D. Salaberger, M. Rami, C. Hochenauer, V. Hacker
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621218	PEMBeyond	Discrete ejector control solution design, characterization, and verification in a 5 kW PEMFC system	K. Nikiforow, P. Koski, J. Ihonen
621218	PEMBeyond	Power ramp rate capabilities of a 5 kW proton exchange membrane fuel cell system with discrete ejector control	K. Nikiforow, J. Pennanen, J. Ihonen, S. Uski, P. Koski
621218	PEMBeyond	Pressure swing adsorption for hydrogen purification using a copper modified activated carbon – High recovery and low carbon monoxide content	Frederico Relvas, Roger D. Whitley, Carlos Silva, Adélio Mendes
621227	NELLHI	Aggravated test of IT-SOFC fed with tar-contaminated syngas	Davide Pumiglia, Simone Vaccaro, Andrea Masi, Stephen J. McPhail, Mauro Falconieri, Serena Gagliardi, Livia della Seta, Maurizio Carlini
621228	HYACINTH	Agency and structure in a sociotechnical transition: Hydrogen fuel cells, conjunctural knowledge and structuration in Europe	Upham, P., Dütschke, E., Schneider, U., Oltra, C., Sala, R., Lores, M., Bögel, P., Klapper, R
621228	HYACINTH	A psychology of expectations in sociotechnical systems: the case of hydrogen fuel cell electric vehicles in Europe	Upham, P., Bögel, P., Dütschke, E., Schneider, U., Oltra, C., Sala, R., Lores, M., Klapper, R.
621228	HYACINTH	The public acceptance of Hydrogen Fuel Cell applications in Europe	Christian Oltra
621228	HYACINTH	The role of prior attitudes in technology acceptance: reflections on the case of hydrogen fuel cells	Bögel, P., Oltra, C., Wiemann, P., Sala, R., Lores, M., Upham, P., Dütschke, E., Schneider, U.
621244	ELECTRA	Ba0.5Gd0.8La0.7Co2 6 δ Infiltrated in Porous BaZr0.7Ce0.2Y0.103 Backbones as Electrode Material for Proton Ceramic Electrolytes	Ragnar Strandbakke, Einar Vøllestad, Shay A. Robinson, Marie-Laure Fontaine, Truls Norby
621244	ELECTRA	Development of composite steam electrodes for electrolysers based on barium zirconate	Nuria Bausá, Cecilia Solís, Ragnar Strandbakke, José M. Serra
621244	ELECTRA	Relating defect chemistry and electronic transport in the double perovskite Ba1 xGd0.8La0.2+xCo2O6 δ (BGLC)	Einar Vøllestad, Matthias Schrade, Julie Segalini, Ragnar Strandbakke, Truls Norby
621245	SOCTESQA	An Analysis of the Effects of Test Bench Architecture on Solid Oxide Fuel Cell and Electrolysis Characterization and the Role of International Standards	Marco Graziadio, Bruno Conti, Antonella Giannini, Carlos Boigues Munoz, Stephen J. McPhail, Maurizio Carlini

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Energy Conversion and Management	993-1002	Vol. 148	Elsevier Limited	2017	NO
Catalysis Today	181-189	Vol. 304	Elsevier	2018	NO
Energy Technology	-	-	Wiley	2017	NO
ECS Transactions	2987-2995	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
Polish Journal of Chemical Technology	17-26	Vol. 19/Issue 1	Szczecin University of Technology	2017	YES
ECS Transactions	133-144	Vol. 78/Issue 1	The Electrochemical Society	2017	NO
Energies	2103	Vol. 10/Issue 12	Molecular Diversity Preservation International	2017	YES
Polish Journal of Chemical Technology	20-26	Vol. 19/Issue 3	Szczecin University of Technology	2017	YES
International Journal of Hydrogen Energy	16920-16931	Vol. 42/Issue 27	Elsevier Limited	2017	YES
Reviews in Chemical Engineering	217-235	Vol. 33/Issue 3	Walter de Gruyter GmbH & Co. KG	2017	YES
Polish Journal of Chemical Technology	8-15	Vol. 19/Issue 4	Szczecin University of Technology	2017	YES
Fuel Cells	18-26	Vol. 17/Issue 1	John Wiley and Sons Ltd	2017	NO
Electrochimica Acta	215-225	Vol. 232	Elsevier Limited	2017	NO
International Journal of Hydrogen Energy	16760-16772	Vol. 42/Issue 26	Elsevier Limited	2017	YES
Journal of Power Sources	30-37	Vol. 381	Elsevier	2018	YES
Industrial and Engineering Chemistry Research	-	-	American Chemical Society	2018	NO
Journal of Power Sources	150-159	Vol. 340	Elsevier	2017	NO
Energy Research and Social Science	xx-xx (Accepted)	xx-xx (Accepted)	Elsevier	2017	NO
Technological Forecasting and Social Change	xx-xx (In review)	xx-xx (In review)	Elsevier Inc.	2017	NO
Revista Internacional de Sociologia	xx-xx (To be published)	xx-xx (To be published)	CSIC Consejo Superior de Investigaciones Cientificas	2017	YES
Journal of Cleaner Production	xx-xx (Submitted)	xx-xx (Submitted)	Elsevier Limited	2017	NO
Journal of the Electrochemical Society	F196-F202	Vol. 164/Issue 4	Electrochemical Society, Inc.	2017	NO
Solid State Ionics	62-68	Vol. 306	Elsevier	2017	NO
Journal of Materials Chemistry A	15743 – 15751	Vol. 5	Royal Society of Chemistry	2017	NO
ECS Transactions	15-22	Vol. 75/Issue 37	The Electrochemical Society	2017	YES

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621252	PECDEMO	A copper nickel mixed oxide hole selective layer for Au-free transparent cuprous oxide photocathodes	Min-Kyu Son, Ludmilla Steier, Marcel Schreier, Matthew T. Mayer, Jingshan Luo, Michael Grätzel
621252	PECDEMO	Beating the Efficiency of Photovoltaics-Powered Electrolysis with Tandem Cell Photoelectrolysis	Avner Rothschild, Hen Dotan
621252	PECDEMO	Photocurrent of BiVO 4 is limited by surface recombination, not surface catalysis	Carolin Zachäus, Fatwa F. Abdi, Laurence M. Peter, Roel van de Krol
621252	PECDEMO	Photoelectrochemical water splitting in separate oxygen and hydrogen cells	Avigail Landman, Hen Dotan, Gennady E. Shter, Michael Wullenkord, Anis Houaijia, Artjom Maljusch, Gideon S. Grader, Avner Rothschild
671396	AutoRE	Membranes in energy systems with CO2 capture	Peters, T.A.
671396	AutoRE	Numerical assessment of an automotive derivative CHP fuel cell system	Andrea Luigi Facci, Gabriele Loreti, Stefano Ubertini, Frano Barbir, Thomas Chalkidis, Rolf-Peter Eßling, Thijs Peters, Efthali Skoufa, Roberto Bove
671396	AutoRE	Palladium membranes – from innovation to industrial application	T.A. Peters, P.M. Rørvik, T.O. Sunde, M. Stange, F. Roness, T.R. Reinertsen, J.H. Ræder, Y. Larring, R. Bredesen
671396	AutoRE	Palladium (Pd) membranes as key enabling technology for pre-combustion CO2 capture and hydrogen production	T.A. Peters, P.M. Rørvik, T.O. Sunde, M. Stange, F. Roness, T.R. Reinertsen, J.H. Ræder, Y. Larring, R. Bredesen
671396	AutoRE	Scale-up and demonstration of inorganic membranes for gas separation and membrane reactors	M. Stange, M.L. Fontaine, T.A. Peters, R. Bredesen
671403	INNO-SOFC	Determination of Temperature and Fuel Utilization Distributions in SOFC Stacks with EIS	J. Tallgren, C. Muñoz, J. Mikkola, O. Himanen, J. Kiviaho
671459	BIONICO	Achievements of European projects on membrane reactor for hydrogen production	Gioele Di Marcoberardino, Marco Binotti, Giampaolo Manzolini, José Luis Viviente, Alba Arratibel, Leonardo Roses, Fausto Gallucci
671459	BIONICO	Effect of Au addition on hydrogen permeation and the resistance to H2S on Pd-Ag alloy membranes	Jon Melendez, Niek de Nooijer, Kai Coenen, Ekain Fernandez, Jose Luis Viviente, Martin van Sint Annaland, P.L. Arias, D.A. Pacheco Tanaka, Fausto Gallucci
671459	BIONICO	Palladium based membranes and membrane reactors for hydrogen production and purification: An overview of research activities at Tecnalia and TU/e	E. Fernandez, A. Helmi, J.A. Medrano, K. Coenen, A. Arratibel, J. Melendez, N.C.A. de Nooijer, V. Spallina, J.L. Viviente, J. Zuñiga, M. van Sint Annaland, D.A. Pacheco Tanaka, F. Gallucci
671470	DEMOSOFC	Carbon recovery and re-utilization (CRR) from the exhaust of a solid oxide fuel cell (SOFC): Analysis through a proof-of-concept	M. Santarelli, L. Briesemeister, M. Gandiglio, S. Herrmann, P. Kuczynski, J. Kupecki, A. Lanzini, F. Llovell, D. Papurello, H. Spliethoff, B. Swiatkowski, J. Torres-Sanglas, L.F. Vega
671470	DEMOSOFC	Dealing with fuel contaminants in biogas-fed solid oxide fuel cell (SOFC) and molten carbonate fuel cell (MCFC) plants: Degradation of catalytic and electro-catalytic active surfaces and related gas purification methods	Andrea Lanzini, Hossein Madi, Vitaliano Chiodo, Davide Papurello, Susanna Maisano, Massimo Santarelli, Jan Van herle
671470	DEMOSOFC	Dynamic model with experimental validation of a biogas-fed SOFC plant	G. D'Andrea, M. Gandiglio, A. Lanzini, M. Santarelli
671470	DEMOSOFC	Life Cycle Assessment (LCA) of biogas-fed Solid Oxide Fuel Cell (SOFC) plant	E. Rillo, M. Gandiglio, A. Lanzini, S. Bobba, M. Santarelli, G. Blengini
671470	DEMOSOFC	Reporting Degradation from Different Fuel Contaminants in Ni-anode SOFCs	A. Lanzini, D. Ferrero, D. Papurello, M. Santarelli
671470	DEMOSOFC	Solar-assisted integrated biogas solid oxide fuel cell (SOFC) installation in wastewater treatment plant: Energy and economic analysis	A.S. Mehr, M. Gandiglio, M. MosayebNezhad, A. Lanzini, S.M.S. Mahmoudi, M. Yari, M. Santarelli
671481	SElySOs	Ceramic Fuel Electrodes for Reversible Solid Oxide Cells Operating on Carbon Dioxide	Stella Balomenou, Kalliopi Maria Papazisi, Dimitrios Tsiplakides
671481	SElySOs	High Temperature Co-Electrolysis of CO_2 and Water on Doped Lanthanum Chromites	Kalliopi-Maria Papazisi, Dimitrios Tsiplakides, Stella Balomenou
671481	SElySOs	Insights into the Surface Reactivity of Cermet and Perovskite Electrodes in Oxidizing, Reducing, and Humid Environments	Fotios Paloukis, Kalliopi M. Papazisi, Thierry Dintzer, Vasiliki Papaefthimiou, Viktoriia A. Saveleva, Stella P. Balomenou, Dimitrios Tsiplakides, Fabrice Bournel, Jean-Jacques Gallet, Spyridon Zafeiratos
671481	SElySOs	In situ X-ray photoelectron spectroscopy study of complex oxides under gas and vacuum environments	F. Paloukis, K.M. Papazisi, S.P. Balomenou, D. Tsiplakides, F. Bournel, J.-J. Gallet, S. Zafeiratos

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Energy and Environmental Science	912-918	Vol. 10/Issue 4	Royal Society of Chemistry	2017	NO
ACS Energy Letters	45-51	Vol. 2/Issue 1	American Chemical Society	2017	NO
Chemical Science	3712-3719	Vol. 8/Issue 5	Royal Society of Chemistry	2017	YES
Nature Materials	N/A	N/A	Nature Publishing Group	2017	NO
Presentation at Dr. HiperGas workshop			Dr. HiperGas	2017	NO
Energy Procedia/Proceedings of the 8th International Conference on Applied Energy ICAE2016		1876-6102	Elsevier	2017	YES
Presentation at CLIMIT SUMMIT 2017			Norwegian Research Council	2017	NO
Presentation at EERA AMPEA workshop on 'Materials for membranes in energy applications: gas separation membranes, electrolysers and fuel cells'			SINTEF	2017	YES
Presentation at Third European Workshop on Membrane reactors: Membrane Reactors for Process Intensification			EU projects BIONICO, FERRET, FluidCELL, MEMERE, ROMEO	2017	YES
ECS Transactions	2141-2150	Vol. 78/Issue 1	Electrochemical Society, Inc.	2017	YES
Journal of Cleaner Production	1442-1450	09596526	Elsevier BV	2017	YES
Journal of Membrane Science	329-341	03767388	Elsevier BV	2017	NO
International Journal of Hydrogen Energy	13763-13776	03603199	Pergamon Press Ltd.	2017	NO
Journal of CO2 Utilization	206-221	22129820	Elsevier BV	2017	YES
Progress in Energy and Combustion Science	150-188	03601285	Pergamon Press Ltd.	2017	YES
Energy Conversion and Management	21-34	01968904	Pergamon Press Ltd.	2017	YES
Energy	585-602	03605442	Pergamon Press Ltd.	2017	YES
Fuel Cells	423-433	16156846	John Wiley & Sons Ltd.	2017	NO
Applied Energy	620-638	03062619	Pergamon Press Ltd.	2017	YES
ECS Transactions	3237-3245	19385862	Electrochemical Society, Inc.	2017	NO
ECS Transactions	3197-3204	19385862	Electrochemical Society, Inc.	2017	NO
ACS Applied Materials & Interfaces	25265-25277	19448244	American Chemical Society	2017	NO
Applied Surface Science	1176-1181	01694332	Elsevier BV	2017	NO

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671481	SElySOs	Is Steam an Oxidant or a Reductant for Nickel/Doped-Ceria Cermets?	Vasiliki Papaefthimiou, Dimitris K. Niakolas, Fotios Paloukis, Thierry Dintzer, Spyridon Zafeiratos
671481	SElySOs	LSC Infiltrated LSCF Oxygen Electrode for High Temperature Steam Electrolysis	Vaibhav Vibhu, Saffet Yildiz, Severin Robert Foit, Kevin Schiemann, Izaak C. Vinke, Rüdiger-Albert Eichel, L.G.J. de Haart
671481	SElySOs	Modified NiO/GDC Cermets as Possible Cathode Electrocatalysts for H2O Electrolysis and H2O/CO_2 Co-Electrolysis Processes in SOECs	Evangelia T. Ioannidou, Charalampos S. Neofytides, Stylianos G. Neophytides, Dimitrios K. Niakolas
671481	SElySOs	Operando observation of nickel/ceria electrode surfaces during intermediate temperature steam electrolysis	Vasiliki Papaefthimiou, Dimitris K. Niakolas, Fotios Paloukis, Detre Teschner, Axel Knop-Gericke, Michael Haevecker, Spyridon Zafeiratos
671486	HEALTH-CODE	A Kalman Filter Based Approach to PEM Fuel Cell Fault Detection	G.Buonocunto, G.Spagnuolo, W.Zamboni
699892	ECo	Effects of Pressure on High Temperature Steam and Carbon Dioxide Co-electrolysis	L. Bernadet, J. Laurencin, G. Roux, D. Montinaro, F. Mauvy, M. Reytier
699892	ECo	Integrated System Design of a Small-scale Power-to-Methane Demonstrator	Ligang Wang, Alberto Mian, Luiz C.R. de Sousa, Stefan Diethelm, Jan Van herle, François Maréchal
699892	ECo	Long Term Testing of Solid Oxide Electrolysis Cells under Co-Electrolysis Conditions	Megha Rao, Xiufu Sun, Anke Hagen
699892	ECo	Optimal design of solid-oxide electrolyser based power-to-methane systems: A comprehensive comparison between steam electrolysis and co-electrolysis	Ligang Wang, Mar Pérez-Fortes, Hossein Madi, Stefan Diethelm, Jan Van herle, François Maréchal
700008	HPEM2GAS	Enhanced performance and durability of low catalyst loading PEM water electrolyser based on a short-side chain perfluorosulphonic ionomer	Stefania Siracusano, Vincenzo Baglio, Nicholas Van Dijk, Luca Merlo, Antonino Salvatore Aricò
700008	HPEM2GAS	New insights into the stability of a high performance nanostructured catalyst for sustainable water electrolysis	Stefania Siracusano, Nejc Hodnik, Primoz Jovanovic, Francisco Ruiz-Zepeda, Martin Šala, Vincenzo Baglio, Antonino Salvatore Aricò
700008	HPEM2GAS	Sulphated titania as additive in Nafion membranes for water electrolysis applications	S. Siracusano, V. Baglio, I. Nicotera, L. Mazzapioda, A.S. Aricò, S. Panero, M.A. Navarra
700008	HPEM2GAS	The influence of iridium chemical oxidation state on the performance and durability of oxygen evolution catalysts in PEM electrolysis	S. Siracusano, V. Baglio, S.A. Grigoriev, L. Merlo, V.N. Fateev, A.S. Aricò
700101	Giantleap	Experimental diagnostics and modelling of inductive phenomena at low frequencies in impedance spectra of proton exchange membrane fuel cells	Ivan Pivac, Boris Šimić, Frano Barbir
700101	Giantleap	Model-based strategy oriented to PEMFC system prognostic for Bus transportation applications based on EMR formalism	Petrone, Raffaele; Yousfi Steiner, Nadia; Jemeï, Samir; Harel, Fabien; Hissel, Daniel; Péra, Marie-Cécile
700101	Giantleap	Rejuvenation of fuel cells	Zenith, Federico; Tjønnås, Johannes; Halvorsen, Ivar Johan
700127	INSPIRE	A comparison of rotating disc electrode, floating electrode technique and membrane electrode assembly measurements for catalyst testing	Sladjana Martens, Ludwig Asen, Giorgio Ercolano, Fabio Dionigi, Chris Zalitis, Alex Hawkins, Alejandro Martinez Bonastre, Lukas Seidl, Alois C. Knoll, Jonathan Sharman, Peter Strasser, Deborah Jones, Oliver Schneider
700127	INSPIRE	Multilayer Hierarchical Nanofibrillar Electrodes with Tuneable Lacunarity with 2D like Pt Deposits for PEMFC	Giorgio Ercolano, Filippo Farina, Sara Cavaliere, Deborah J. Jones, Jacques Rozière
700190	HYTECH-CYCLING	Assessment of Critical Materials and Components in FCH Technologies to Improve LCIA in End of Life Strategy	Andrej Lotrič, Rok Stropnik, Boštjan Drobnič, Boštjan Jurjevčič, Mihael Sekavčnik, Mitja Mori, Ana María Férriz Quílez
700266	Cell3Ditor	Aqueous metal–organic solutions for YSZ thin film inkjet deposition	C. Gadea, Q. Hanniet, A. Lesch, D. Marani, S. H. Jensen, V. Esposito
700266	Cell3Ditor	Continuous hydrothermal flow synthesis of Gd-doped CeO2 (GDC) nanoparticles for inkjet printing of SOFC electrolytes	Yu Xu, Nicholas Farandos, Massimo Rosa, Philipp Zielke, Vincenzo Esposito, Peter Vang Hendriksen, Søren Højgaard Jensen, Tao Li, Geoffrey Kelsall, Ragnar Kiebach
700266	Cell3Ditor	Three dimensional printing of components and functional devices for energy and environmental applications	J. C. Ruiz-Morales, A. Tarancón, J. Canales-Vázquez, J. Méndez-Ramos, L. Hernández-Afonso, P. Acosta-Mora, J. R. Marín Rueda, R. Fernández-González
700266	Cell3Ditor	Zirconia nano-colloids transfer from continuous hydrothermal synthesis to inkjet printing	M. Rosa, P.N. Gooden, S. Butterworth, P. Zielke, R. Kiebach, Y. Xu, C. Gadea, V. Esposito

Journal title	Relevant pages	ISSN/Publication frequency[142]	Publisher	Publication year	Open Access[143]
ChemPhysChem	164-170	14394235	John Wiley & Sons Ltd.	2017	YES
ECS Transactions	3283-3295	19385862	Electrochemical Society, Inc.	2017	NO
ECS Transactions	3267-3274	19385862	Electrochemical Society, Inc.	2017	NO
Journal of Catalysis	305-313	00219517	Academic Press	2017	NO
Proceedings of 26th IEEE International Symposium on Industrial Electronics,19-21 June 2017, Edinburgh, UK	934-939		IEEE ISIE-International Symposium on Industrial Electronics	2017	NO
Electrochimica Acta	114-127	00134686	Pergamon Press Ltd.	2017	NO
Chemical Engineering Transactions	1339 – 1344	978-88-95608-51-8	The Italian Association of Chemical Engineering – AIDIC Servizi	2017	YES
ECS Transactions	57-69	19385862	Electrochemical Society, Inc.	2017	YES
Applied Energy	1060-1079	03062619	Pergamon Press Ltd.	2018	NO
Applied Energy	477-489	03062619	Pergamon Press Ltd.	2017	YES
Nano Energy	618-632	22112855	Elsevier BV	2017	YES
International Journal of Hydrogen Energy	In press	03603199	Pergamon Press Ltd.	2017	NO
Journal of Power Sources	105-114	03787753	Elsevier BV	2017	YES
Journal of Power Sources	240-248	03787753	Elsevier BV	2017	YES
7th International Conference on Fundamentals and Development of Fuel Cells			FDFC 2017	2017	YES
European Fuel Cell Car Workshop			EFCW 2017	2017	YES
Journal of Power Sources	274-284	03787753	Elsevier BV	2018	YES
ECS Transactions	757-762	19385862	Electrochemical Society, Inc.	2017	YES
Proceedings of 10th International Conference on Sustainable Energy and Environmental Protection, 27-30 June 2017, Bled, Slovenia.	100-111		University of Maribor Press	2017	NO
Journal of Materials Chemistry C	6021-6029	20507534	Royal Society of Chemistry	2017	YES
International Journal of Applied Ceramic Technology	315-327	1546542X	American Ceramic Society	2018	YES
Energy and Environmental Science	846-859	1754-5706	The Royal Society of Chemistry	2017	YES
Journal of the European Ceramic Society	2-8	09552219	Elsevier BV	2017	YES

Project number	Project acronym	Publication title	Authors
700266	Cell3Ditor	Zirconia UV-curable colloids for additive manufacturing via hybrid inkjet printing-stereolithography	M. Rosa, C. Barou, V. Esposito
700300	GrInHy	Green Industrial Hydrogen via Reversible High-Temperature Electrolysis	Konstantin Schwarze, Oliver Posdziech, Simon Kroop, Nieves Lapeña-Rey, Joshua Mermelstein
700300	GrInHy	Performance Characterization of Glass-Ceramic Sealants in Dual Atmosphere Environment for Reversible Solid Oxide Cell (R-SOC) Applications	Domenico Ferrero, Antonio Gianfranco Sabato, Hassan Javed, Andrea Lanzini, Kai Herbrig, Christian Walter, Massimo Santarelli, Federico Smeacetto
700355	HyGrid	Advancement in Palladium Membranes Hydrogen Purification	M. Succi, G. Macchi, E. Fernandez, J. Melendez, J. L. Viviente, D.A Pacheco Tanaka
700355	HyGrid	Development of carbon molecular sieve Membranes for the use of renewable gases, biomethane and hydrogen in natural gas networks	A.M. Gutierrez, J.R. Arraibi, M.A. Llosa Tanco, J. Zúñiga, J.L. Viviente, L. García Gómez
700355	HyGrid	Electrochemical Compressor for Hydrogen Separation in a Small-Scale Hybrid System	M. Nordio, M. Van Sint Annaland, F. Gallucci, V. Spallina, M. Mulder, L. Raymakers, P. Bouwman
700355	HyGrid	Flexible Hybrid separation system for H2 recovery from Natural Gas Grids (HyGrid)	A.M. Gutierrez,
700355	HyGrid	Flexible Hybrid separation system for H2 recovery from NG Grids	F. Gallucci, J.L. Viviente
700355	HyGrid	Hidrógeno en redes de gas natural	A.M. Gutierrez
700355	HyGrid	Hybrid separation system for hydrogen recovery from natural gas grids	M. Nordio, J. Meléndez, D.A. Pacheco Tanaka, M. Mulder, P. Bouwman, L. Raymakers, M. Van Sint Annaland, F. Gallucci
700355	HyGrid	Pd Supported Membrane Hydrogen Purifier: a comparison with other technologies	M. Succi, G. Macchi
700355	HyGrid	Preparation and hydrogen permeation studies of ultra-thin Palladium (≈1 micrometre) and carbon membranes from mixtures containing low concentration of hydrogen (< 30 %)	D.A. Pacheco Tanaka, M.A. Llosa Tanco, J. Medrano, J. Melendez, E. Fernández, M. Nordio, F. Gallucci
700355	HyGrid	Ultra-thin palladium-silver membranes for pure hydrogen production and separation: modelling and effect of sweep gas	M. Nordio, J. Meléndez, E. Fernández, M. Van Sint Annaland, D.A. Pacheco Tanaka, F. Gallucci
700564	HEATSTACK	Effect of Alloy Composition on the Oxidation Behaviour and Cr Vaporisation of High-Cr Steels for SOFC Cathode Air Preheater	Kun Zhanga, Jong-Eun Hongb, Robert Steinberger-Wilckensa
735160	qSOFC	Artificial intelligence for automatic optical inspection of multilayered solid oxide membranes	Anton Litke, Petrus Martens, Ronald van Olmen, Greg Norsworthy, Roderik Höppener
735160	qSOFC	Long term stability of a Mn-rich precoated AISI 441 for Solid Oxide Fuel Cell Interconnects at 650 °C in air	Carlos Bernuy-Lopez, Robert Berger, Jörgen Westlinder
735160	qSOFC	Mass-manufacturing and quality assurance of SOFC stacks in FCH 2 JU projects qSOFC and INNO-SOFC	Markus Rautanen, Olli Himanen, Jyrki Mikkola, Johan Tallgren, Enn Õunpuu, Sergii Pylypko, Matti Noponen, Paul Hallanoro, Jukka Göös, Anton Litke, Roderik Höppener, Simon Hailer, Uwe Maier, Robert Berger, Stephen McPhail, Lars Steckkönig
735160	qSOFC	Sandvik surface technology: a solution for mass production of fuel cells	Carlos Bernuy-Lopez, Robert Berger, Mikael Stenström, Jörgen Westlinder
735218	PECSYS	Spontaneous galvanic displacement of Pt nanostructures on nickel foam: Synthesis, characterization and use for hydrogen evolution reaction	Rachela G. Milazzo, Stefania M.S. Privitera, Daniele D'Angelo, Silvia Scalese, Salvatore Di Franco, Francesco Maita, Salvatore Lombardo
735367	INLINE	Scalable assembly for fuel cell production	Tom Stähr, Florian Ungermann, Gisela Lanza
735485	QualyGridS	Application of Water Electrolysers in the Swiss Balancing Service Markets	Imboden, C., Chacko, A.

Journal title	Relevant pages	ISSN/Publication frequency[142]	Publisher	Publication year	Open Access[143]
Materials Letters	214-217	0167577X	Elsevier BV	2018	YES
ECS Transactions	2943-2952	19385862	Electrochemical Society, Inc.	2017	YES
ECS Meeting Abstracts		2151-2043	ECS – The Electrochemical Society	2017	YES
6th European PEFC and Electrolyser Forum, 4-7 July 2017, Lucerne, Switzerland. Poster.			N/A	2017	NO
Proceeding of International Gas Union Research Conference 2017 (IGRC 2017), 24-26 May 2017, Rio de Janeiro, Brazil.			International Gas Union	2017	NO
13th International Conference on Catalysis in Membrane Reactors (ICCMR13), 10-13 July 2017, Houston Texas, USA. Oral presentation.			ICCMR	2017	NO
GERG Meeting with DG ENERGY, 6 February 2017, Brussels, Belgium.			DG ENERGY	2017	NO
Third European Workshop on Membrane reactors: Membrane Reactors for Process Intensification (MR4PI2017), Villafranca di Verona, Italy, 9-10 March 2017. Poster.			N/A	2017	YES
Fronteras Tecnológicas en Generación de Electricidad, Energías Renovables e Hidrógeno Workshop, 26 April 2017, Madrid, Spain. Oral presentation.			N/A	2017	NO
10th World Congress of Chemical Engineering (WCCE10), 1-5 November 2017, Barcelona, Spain. Oral presentation.			WCCE	2017	NO
Third European Workshop on Membrane reactors: Membrane Reactors for Process Intensification (MR4PI2017), 9-10 March 2017, Villafranca di Verona, Italy. Poster.			N/A	2017	YES
13th International Conference on Catalysis in Membrane Reactors (ICCMR13), 10-13 July 2017, Houston Texas, USA. Oral presentation: keynote.			ICCMR	2017	NO
13th International Conference on Catalysis in Membrane Reactors (ICCMR13), 10-13 July 2017, Houston Texas, USA. Oral presentation.			ICCMR	2017	NO
The Electrochemical Society		2151-2043	The Electrochemical Society	2017	NO
European SOE & SOFC Forum			European SOE & SOFC Forum	2018	YES
European SOE & SOFC Forum			European SOE & SOFC Forum	2018	YES
European SOE & SOFC Forum			European SOE & SOFC Forum	2018	YES
International Hydrogen and Fuel Cells Conference			International Hydrogen and Fuel Cells Conference	2018	YES
International Journal of Hydrogen Energy	7903-7910	03603199	Pergamon Press Ltd.	2018	YES
7. WGP -Jahreskongress Aachen, Germany.	303-311	978-3-86359-555-5	Robert Schmitt, Günther Schuh	2017	NO
Proceedings of the 6th European PEFC & Electrolyser Forum, 4-7 July 2017, Lucerne, Switzerland.	134-146	978-3-905592-22-1	European Fuel Cell Forum	2017	YES

Project number	Project acronym	Publication title	Authors
735485	QualyGridS	Integration of demand-side response in the Swiss ancillary service markets through the ENTSO-E central settlement model	Chacko, A., Imboden, C., Kummer, R., Reithofer, T.
735485	QualyGridS	Presentación del proyecto QualyGridS: Test estandarizados para la cualificación de electrolizadores desarrollando servicios de red.	R. Reissner, L. Abadía, R. Canalejas, V. Gil
735485	QualyGridS	QualyGridS – Standardized qualifying tests of electrolysers for grid services	Reissner, R. (DLR); Soreng, Anders (NEL); van Dijk, Nick (ITM Powe; Abadia, Laura, (Aragon Hydrogen Foundatio; Bourasseau, Cyril (CEA(; You, Shi (DTU); Traeholt, Chresten (DTU); de Jong, Francoise (NEN); Marcuello, Pablo (IHT); Imboden, Christoph (Hochschule Luzern); Sprig, Michael (European Fuel Cell Forum)
735485	QualyGridS	QualyGridS – Standardized qualifying tests of electrolysers for grid services	Regine Reissner, Marius Bornstein, Ben Green, Laura Abadía, Cyril Bourasseau, Shi You, Chresten Tr holt, Francoise de Jong, Pablo Marcuello, Christoph Imboden, M. Spirig et al.
735485	QualyGridS	QualyGridS – Standardized qualifying tests of electrolysers for grid services	Reissner, R.; Soreng, Anders; van Dijk, Nick; Abadia, Laura; Bourasseau, Cyril; You, Shi; Traeholt, Chresten; de Jong, Francoise; Marcuello, Pablo; Imboden, Christoph; Sprig, Michael
735533	MEMPHYS	Engineering toolbox for flowfield plates with automated mesh generation	U. Reimer, D. Froning, S. B. Beale, W. Lehnert
735533	MEMPHYS	Membrane based purification of hydrogen system	L. Schorer, S. Schmitz, A. Weber
735692	CH2P	Characterization of the local morphology at triple-phase boundaries after SOFC/SOEC operation	G. Rinaldi, A. Nakajo, M. Cantoni, W.K.S. Chiu, J. Van herle
735692	CH2P	Process optimization of a SOFC system for the combined production of hydrogen and electricity	M. Pérez-Fortes, A. Mian, S. Diethelm, L. Wang, F. Maréchal, J. Van herle, S. Santhanam, M.P. Heddrich, S.F. Au, E. Varkaraki, Z. Wuillemin, R. Makkus, I. Mirabelli, R. Schoon, M. Grippa, M. Testi, L. Crema
735692	CH2P	Thermo-mechanical reliability of SOFC stacks: impact of component tolerances and operating conditions	F. Greco, A. Nakajo, Z. Wuillemin, J. Van herle
735918	INSIGHT	Carbon Deposition Diagnostics for Reliability and State-of-Health Assessment of SOFC	Alexandra Ploner, Anke Hagen, Anne Hauch
735918	INSIGHT	Experimental validation of a La0.6Sr0.4Co0.2Fe0.8O3 δ electrode model operated in electrolysis mode: Understanding the reaction pathway under anodic polarization	F. Monaco, V. Tezyk, E. Siebert, S. Pylypko, B. Morel, J. Vulliet, T. Le Bihan, F. Lefebvre-Joud, J. Laurencin
735918	INSIGHT	Impact of Nickel agglomeration on Solid Oxide Cell operated in fuel cell and electrolysis modes	M. Hubert, J. Laurencin, P. Cloetens, B. Morel, D. Montinaro, F. Lefebvre-Joud
735969	INN-BALANCE	Enhancing the Efficiency and Lifetime of a Proton Exchange Membrane Fuel Cell Using Nonlinear Model-Predictive Control With Nonlinear Observation	Julio Luna, Elio Usai, Attila Husar, Maria Serra
735969	INN-BALANCE	Temperature control of open-cathode PEM fuel cells	Stephan Strahl, Ramon Costa-Castelló
736648	NET-Tools	Blast wave after hydrogen storage tank rupture in a tunnel fire	V. Shentsov, D. Makarov, V. Molkov
736648	NET-Tools	Blast wave and fireball after hydrogen tank rupture in a fire	V. Molkov, D. M. C. Cirrone, V. Shentsov, W. Dery, W. Kim, D. Makarov
736648	NET-Tools	Deflagrations of localised homogeneous and inhomogeneous hydrogen-air mixtures in enclosures	D. Makarov, P. Hooker, M. Kuznetsov, V. Molkov
736648	NET-Tools	Effect of a heat release rate on reproducibility of fire test for hydrogen storage cylinders	Sergii Kashkarov, Dmitriy Makarov, Vladimir Molkov
736648	NET-Tools	Hands-on session on e-Laboratory and lectures on Hydrogen Safety	V. Shentsov, D. Makarov, V. Molkov
736648	NET-Tools	Model of 3D conjugate heat transfer and mechanism of compressed gas storage failure in a fire	S. Kashkarov, D. Makarov, V. Molkov

Journal title	Relevant pages	ISSN/Publication frequency[142]	Publisher	Publication year	Open Access[143]
15. Symposium Energieinnovation, Graz, Austria.			HSLU	2018	YES
Communications Book III, Ibero-American Congress on Hydrogen and Fuel Cells, 17-20 October 2017, Huesca, Spain.	189-190	978-84-697-6342-1	Spanish Fuel Cell Association (APPICE)	2017	YES
Proceedings of 6th European PEFC & Electrolyser Forum, 4-7 July 2017, Lucerne, Switzerland.			European Fuel Cell Forum	2017	YES
European Grid Service Markets Symposium, 5 July 2018, Lucerne, Switzerland.			Lucerne University of Applied Science & Arts and European Fuel Cell Forum	2018	YES
Proceedings of 6th European PEFC & Electrolyser Forum, 5-7 July 2017, Lucerne, Switzerland.			European Fuel Cell Forum	2017	YES
15th Symposium on Modelling and Validation of Electrochemical Energy Devices, ModVal 2018, 12-13 April 2018, Aarau, Switzerland.	156-157		Paul Scherrer Institut	2018	YES
Proceedings of European Hydrogen Energy Conference, 14-16 March 2018, Malaga, Spain.		978-84-09-01620-4	EHEC	2018	NO
Proceedings of 13th European SOFC & SOE Forum, 3-6 July 2018, Lucerne, Switzerland. B0304.		978-3-905592-23-8	European Fuel Cell Forum AG	2018	NO
Proceedings of 13th European SOFC & SOE Forum, 3-6 July 2018, Lucerne, Switzerland. Chapter 06, Session A13.	106-117	978-3-905592-23-8	European Fuel Cell Forum AG	2018	NO
Proceedings of 13th European SOFC & SOE Forum, 3-6 July 2018, Lucerne, Switzerland. A1403.		978-3-905592-23-8	European Fuel Cell Forum AG	2018	NO
ECS Transactions	25-32	19385862	Electrochemical Society, Inc.	2018	NO
Solid State Ionics	234-246	01672738	Elsevier BV	2018	YES
Journal of Power Sources	240-251	03787753	Elsevier BV	2018	NO
IEEE Transactions on Industrial Electronics	6649-6659	02780046	Institute of Electrical and Electronics Engineers	2017	YES
IFAC-PapersOnLine	11088-11093	24058963	Elsevier	2017	YES
Presentation at 8th International Symposium on Tunnel Safety and Security, 14-16 March 2018, Borås, Sweden.			ISTSS	2018	YES
11th International Colloquium on Pulsed and Continuous Detonations (ICPCD), 17-21 September 2018, St. Petersburg, Russia.			ICPCD	2018	YES
International Journal of Hydrogen Energy	9848-9869	03603199	Pergamon Press Ltd.	2018	YES
International Journal of Hydrogen Energy	10185-10192	03603199	Pergamon Press Ltd.	2018	YES
Presentations at Joint European Summer School, 2018.			JESS2018	2018	YES
International Conference on Hydrogen Safety			HySAFE	2017	YES

Project number	Project acronym	Publication title	Authors
736648	NET-Tools	NET-Tools, an e-infrastructure to compile and provide e-learning content to the FCH-community	O. Jedicke, G. Cinti, E. Slavcheva
736648	NET-Tools	Non-adiabatic blowdown model: a complementary tool for the safety design of tank-TPRD system	M. Dadashzadeh, D. Makarov, V. Molkov
736648	NET-Tools	Physical model of onboard hydrogen storage tank thermal behaviour during fuelling	M. Dadashzadeh, D. Makarov, V. Molkov
736648	NET-Tools	Pressure peaking phenomenon: Model validation against unignited release and jet fire experiments	D. Makarov, V. Shentsov, M. Kuznetsov, V. Molkov
736648	NET-Tools	Risk assessment methodology for onboard hydrogen storage	Mohammad Dadashzadeh, Sergii Kashkarov, Dmitriy Makarov, Vladimir Molkov
736648	NET-Tools	Simulation of FC system integrated into CHP application, including electrolyser operation	G. Cinti, G.Bidini, V. Ciotola
736648	NET-Tools	Simulation of thermal hazards from hydrogen under-expanded jet fire	D.M.C. Cirrone, D. Makarov, V. Molkov
736648	NET-Tools	Simulation of thermal radiation from hydrogen under-expanded jet fire	D. M. C. Cirrone, D. Makarov, V. Molkov
736648	NET-Tools	Simulation of thermal radiation from hydrogen under-expanded jet fire	D. M. C. Cirrone, D. Makarov, V. Molkov
736648	NET-Tools	Socio-economic analysis and quantitative risk assessment methodology for safety design of onboard storage systems	M. Dadashzadeh, S. Kashkarov, D. Makarov, V. Molkov
736648	NET-Tools	Socio-economic analysis and quantitative risk assessment methodology for safety design of onboard storage systems	M. Dadashzadeh, S. Kashkarov, D. Makarov, V. Molkov
736648	NET-Tools	The progress in hydrogen safety research	V. Molkov
736648	NET-Tools	Thermal radiation from cryogenic hydrogen jet fires	D. M. C. Cirrone, D. Makarov, V. Molkov
736648	NET-Tools	Thermal radiation from cryogenic hydrogen jet fires	D.M.C. Cirrone, D. Makarov, V. Molkov
779366	CRESCENDO	Toward Platinum Group Metal-Free Catalysts for Hydrogen/Air Proton-Exchange Membrane Fuel Cells	Frédéric Jaouen, Deborah Jones, Nathan Coutard, Vincent Artero, Peter Strasser, Anthony Kucernak
779469	Haeolus	Hydrogen Export to Svalbard: Exploiting Stranded Wind in Finnmark	Federico Zenith
779469	Haeolus	Large-scale hydrogen production from wind power in Arctic conditions	Federico Zenith
779469	Haeolus	Large-scale hydrogen production from wind power in Arctic conditions	Federico Zenith
779469	Haeolus	Non-Technical Obstacles for Power-to-H2: Hydrogen from Wind Power in Arctic Conditions	Federico Zenith

Journal title	Relevant pages	ISSN/Publication frequency[142]	Publisher	Publication year	Open Access[143]
Proceedings of European Fuel Cell Technology & Applications Piero Lunghi Conference, 12-15 December 2017, Naples, Italy	321-322	978-88-8286-356-2	ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development	2017	YES
Presentation at International Conference on Hydrogen Safety			HySAFE	2017	YES
International Journal of Hydrogen Energy	Submitted	03603199	Pergamon Press Ltd.	2018	YES
International Journal of Hydrogen Energy	9454-9469	03603199	Pergamon Press Ltd.	2018	NO
International Journal of Hydrogen Energy	6462-6475	03603199	Pergamon Press Ltd.	2018	NO
Proceedings of the European Fuel Cell Technology & Applications Piero Lunghi Conference, 12-15 December. Naples, Italy.	365-366	978-88-8286-356-2	ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development	2017	YES
International Journal of Hydrogen Energy		03603199	Pergamon Press Ltd.	2018	YES
International Conference on Hydrogen Safety			HySAFE	2017	YES
Presentation at International Conference on Hydrogen Safety			HySAFE	2017	YES
International Conference on Hydrogen Safety			HySAFE	2017	YES
Presentation at International Conference on Hydrogen Safety			HySAFE	2017	YES
8th International Symposium on Non-equilibrium Processes, Plasma, Combustion, and Atmospheric Phenomena			Torus Press	2018	YES
International Conference on Hydrogen Safety			HySAFE	2017	YES
International Journal of Hydrogen Energy		03603199	Pergamon Press Ltd.	2018	YES
Johnson Matthey Technology Review	231-255	20565135	Johnson Matthey plc	2018	YES
Input meeting for Svalbard's future energy supply			Norway's Ministry for Oil and Energy	2018	YES
IEA HIA Task 38, 5th Plenary Meeting			IEA HIA Task 38	2018	YES
Nordic Hydrogen & Fuel Cell Conference			Nordic Hydrogen & Fuel Cell Conference	2018	YES
Workshop on Power-to-X Demonstrations			IEA HIA Task 38	2018	YES

ANNEX 4
Patents from projects.

The patents relate to the FP7 programme[144].

Application area	Patents 2009-2018	Share of projects with at least 1 patent
Transport and refuelling infrastructure	10	19 %
Stationary power production and combined heat and power	51	27 %
Hydrogen production and distribution	16	35 %
Early markets	3	10 %
Cross-cutting issues	1	5 %
Total JU	81	22 %

144 The table is based on the patents query in the CORDA database for FP7 and H2020 projects; none of the H2020 projects have reported any patents. The list of patents is available upon request.

ANNEX 5
Scoreboard of Horizon 2020 common KPIs[145]

H2020 priority	H2020 KPI number	Key Performance Indicator	Type of data required	Results H2020 up to 31 December 2018 (calls 2014–2018)
INDUSTRIAL LEADERSHIP	12	SME – Share of participating SMEs introducing innovations new to the company or the market (covering the period of the project plus three years)	Number of SMEs that have introduced innovations	34 SMEs
	13	SME – Growth and job creation in participating SMEs	Turnover of company, number of employees	Turnover of SMEs at most recent reporting: EUR 323 911 930 No of employees at SMEs at most recent reporting: 3 116
SOCIETAL CHALLENGES	14	Publications in peer-reviewed high-impact journals	Publications from relevant funded projects (DOI: digital object identifiers); journal impact benchmark (ranking) data to be collected by commercially available bibliometric databases	97 publications in peer-reviewed high-impact journals
	15	Patent applications and patents awarded in the area of the JTI	Patent application number	0
	16	Number of prototypes testing activities and clinical trials	Reports on prototypes, and testing activities, clinical trials	No of prototypes: 50 No of testing activities: 48 No of clinical trials: N/A
	17	Number of joint public-private publications in projects	Properly flagged publications data (DOI) from relevant funded projects	32 joint public-private publications
	18[146]	New products, processes and methods launched on the market	Project count and drop-down list enabling choice of the type processes, products and methods	No of projects with: New products: 21 New processes: 15 New methods: 7

* This indicator is not a legally compulsory one, but it covers several additional specific indicators requested for more societal challenges by the services in charge

145 Based on Annex II to Council Decision 2013/743/EU.

146 This indicator is not a legally compulsory one, but it covers several additional specific indicators requested for more societal challenges by the services in charge.

H2020 priority	H2020 KPI number	Key Performance Indicator	Type of data required	Results H2020 up to 31 December 2018 (calls 2014-2018)
EVALUATIONS	N/A	TIME TO INFORM (TTI) all applicants of the outcome of the evaluation of their application from the final date for submission of completed proposals	Number and % of information letters sent to applicants within target	73 information letters with an average of 108 days (100 % within target)
	N/A	Redress after evaluations	Number of redresses requested	11
GRANTS	N/A	TIME TO GRANT (TTG) measured (average) from call deadline to signature of grants	Number and % of grants signed within target Average TTG in calendar days Maximum TTG in calendar days	90 grant agreements signed (77 % within target) Average TTG: 239 days Maximum TTG: 589 days
	N/A	TIME TO SIGN (TTS) grant agreements from the date of informing successful applicants (information letters)	Number and % of grants signed within target Average TTG in calendar days Maximum TTG in calendar days	90 grant agreements signed Average TTS: 125 days Maximum TTS: 463 days
PAYMENTS	N/A	TIME TO PAY (TTP) (% made on time) - pre-financing - interim payment - final payment	Average number of days for pre-financing, interim payments and final payments Average number of days for administrative payments	Average number of days for pre-financing: 9 (90 % on time) Average number of days for interim payments: 76 (97 % on time) Average number of days for final payments: 88 (100 % on time) Average number of days for administrative payments in 2018: 19
HR	N/A	Vacancy rate (%)	% of post filled in	100 %
JU EFFICIENCY	N/A	Budget implementation/ execution: 1. % commitment appropriations (CA) to total budget 2. % payment appropriation (PA) to total budget	% of CA and PA	In 2018 CA: 93 % PA: 83 %
	N/A	Administrative budget: Number and % of total of late payments	Number of delayed payments % of delayed payments (of the total)	In 2018 48 late payments 5.2 % late payments (of the total)

ANNEX 6
Indicators for monitoring cross-cutting issues[147]

147148149150

Number	Definition/Responding to question	Type of data required	AAR 2018 (CALLS 2014-2018)[148]
2.1	Total number of participations by EU-28 Member State	Nationality of Horizon 2020 applicants and beneficiaries (number)	Applications: 2 276 applications, 982 applicants from EU-28 Grants: 838 participations, 445 participants from EU-28
2.2	Total amount of EU financial contribution by EU-28 Member State (EUR millions)	Nationality of Horizon 2020 beneficiaries and corresponding EU financial contribution	In EUR per country: AT 17 368 839.07; BE 27 706 779.13; BG 389 125; CZ 1 172 831.25; DE 122 878 550.5; DN 20 230 240.29; ES 14 862 558.08; ES 400 425; FI 15 359 382.25; FR 65 126 831.41; UK 67 902 875.94; EL 4 354 087.5; HR 380 000; HU 21 000; IT 39 936 397.51; LT 130 530.28; LU 487 158.56; LV 2 727 311.25; MT 32 999; NL 29 934 806.1; PL 90 167.5; PT 416 085; RO 243 250; SV 1 748 481.25; SE 7 420 430.81 Grand total: 441 321 142.7
N/A	Total number of participations by Associated Countries	Nationality of Horizon 2020 applicants & beneficiaries (number)	Applications: 244 applications, 113 applicants from Associated Countries Grants: 91 participations, 51 participants form Associated Countries
N/A	Total amount of EU financial contribution by Associated Country (EUR millions)	Nationality of Horizon 2020 beneficiaries and corresponding EU financial contribution	In EUR per country: CH 1 899 416.31; IS 1 845 075.00; NO 16 511 179.25; UA 55 125.00 Grand total: 30 310 795.56
3.1	Share of EU financial contribution going to SMEs (Enabling & industrial tech and Part III of Horizon 2020)	Number of Horizon 2020 beneficiaries flagged as SMEs % of EU contribution going to beneficiaries flagged as SMEs	SME participations: 243/935 (26 %) SME participants: 121/498 (24. 3%) SME funding: EUR 148 594 269.34 /EUR 471 606 033.28 (31.5 %)
6.1	Percentage of women participants in Horizon 2020 projects	Gender of participants in Horizon 2020 projects	127/412 (31 %)[149] According to continuous reporting: 16 935/66 556 (25 %)[150]
6.2	Percentage of women project coordinators in Horizon 2020	Gender of MSC fellows, ERC principle investigators and scientific coordinators in other Horizon 2020 activities	Women coordinators: 24/92 (26.1 %)
6.3	Percentage of women in EC advisory groups, expert groups, evaluation panels, individual experts, etc.	Gender of members of advisory groups, panels, etc.	Scientific com. 3/9 (33.3 %) on 31 December 2018 SRG: 10/44 (22.7 %) on 31 December 2018 Evaluators: 28/132 (21.2 %)
7.1	Share of third-country participants in Horizon 2020	Nationality of Horizon 2020 beneficiaries	Two participants from third countries in two different grant agreements without EU funding
7.2	Percentage of EU financial contribution attributed to third-country participants	Nationality of Horizon 2020 beneficiaries and corresponding EU financial contribution	0
9.1	Share of projects and EU financial contribution allocated to Innovation Actions (IAs)	Number of IA proposals and projects properly flagged in the WP; follow-up at grant level	No: 24/92 (26 %) Funding EUR: 276 778 887.34/471 918 063.28 (58.6 %)

147 Based on Annex III to Council Decision 2013/743/EU

148 The figures include 92 projects, including two projects from the 2018 call which were not signed as of 31 December 2018 but which are at an advanced stage of preparation.

149 Based on CORDA query, reflecting the gender ratio among contact persons declared by FCH 2 JU as beneficiaries (per legal entity).

150 Based on CORDA query, reflecting the gender balance among the staff of the FCH 2 JU beneficiaries (per legal entity).

Number	Definition/Responding to question	Type of data required	AAR 2018 (CALLS 2014-2018)[148]
9.2	Within the IAs, share of EU financial contribution focused on demonstration and first-of-a-kind activities	Topics properly flagged in the WP; follow-up at grant level	N/A – none of the FCH 2 JU projects 1.1% (1 project)
N/A	Scale of impact of projects (High Technology Readiness Level)	Number of projects addressing TRL between (2-3, 4-6, 5-7)	Based on TRL specified in the topic (project start) TRL 2: 1 topic – 1 grant, TRL 2-3: 3 topics – 2 grants; TRL <3: 1 topic –1 grant; TRL 3: 22 topics – 21 grants; TRL 3-4: 4 topics – 3 grants; TRL 4: 21 topics – 16 grants; TRL 4-5: 3 topics – 5 grants; TRL 5: 6 topics – 6 grants; TRL 4-6: 1 topic – 0 grants; TRL 5-6: 1 topic – 1 grant; TRL 6: 9 topics – 4 grants; TRL >6: 1 topic – 0 grants; TRL 6-7: 5 topics – 5 grants; TRL 7: 9 topics – 6 grants; TRL >7: 1 topic – 1 grant; TRL 8: 1 topic – 1 grant; N/A: 21 topics – 16 grants (cross-cutting projects); TRL 8-9 for FCVs and TRL 7-8 for HRS: 1 topic – 1 grant
11.1	Percentage of Horizon 2020 beneficiaries from the private-for-profit sector	Number of and % of the total Horizon 2020 beneficiaries classified by type of activity and legal status	Participations: 552/931 (59.3 %), Participants: 320/498 (64.3 %)
11.2	Share of EU financial contribution going to private-for-profit entities (Enabling & industrial tech and Part III of Horizon 2020)	Horizon 2020 beneficiaries classified by type of activity; corresponding EU contribution	EUR 339 886 169.64/ EUR 471 631 938.28 (72 %)[151]
12.1	EU financial contribution for public-private partnerships (PPP) (Art. 187)	EU contribution to PPP (Art. 187)	Cumulative EU contribution to administrative and operational budget for the period 2014-2018: CA: EUR 486 413 586 PA: EUR 318 764 097
12.2	PPPs leverage: total amount of funds leveraged through Art. 187 initiatives, including additional activities, divided by the EU contribution	Total funding made by private actors involved in PPPs - in-kind contribution already committed by private members in projects selected for funding - additional activities (i.e. research expenditures/ investment of industry in the sector, compared to previous year)	1.96 (see section 1.1, Formula B)
13.3	Dissemination and outreach activities other than peer-reviewed publications [conferences, workshops, press releases, publications, flyers, exhibitions, training, social media, websites, communication campaigns (e.g. radio, TV)]	A drop-down list allows the type of dissemination activity to be selected. Number of events, funding amount and number of persons reached thanks to the dissemination activities	Based on manual extraction from 21 projects which had reported within 2018 (including data from previous years) as well as research on the web: 70 websites, 17 Twitter accounts, 3 Facebook accounts, 13 LinkedIn profiles, 7 accounts on other social medial, 8 videos, 7 SlideShares, 51 press releases, 16 newsletters, 6 brochures, 5 posters, 5 flyers, 31 news items (online articles), 141 presentations at conferences or seminars, 14 trade fairs, 37 events (scientific, dissemination, showcase, etc.), 22 workshops, 6 public handover ceremonies of vehicles, 6 HRS opening ceremonies, 1 TV film, 3 radio interviews, 3 awards received, 4 conferences (organised)
14.2	Proposal evaluators by country	Nationality of proposal evaluators	Austria (6), Belgium (1), Canada (2), Switzerland (3), Germany (16), Greece (6), Spain (18), Finland (5), France (12), Hungary (1), Ireland (2), India (3), Italy (22), Lithuania (2), Netherlands (1), Poland (2), Portugal (3), Romania (2), Sweden (3), Turkey (2), United Kingdom (11), United States of America (9)
14.3	Proposal evaluators by organisations' type of activity	Type of activity of evaluators' organisations	Type of activity: No of expert participations (%) • Higher education establishments (42) – 18.2 % • Others/not defined (24) – 10 % • Private-for-profit organisation (30) – 22.7 % • Public organisation (25) – 18.9 % • Research organisation (11) – 8.3 %

Number	Definition/Responding to question	Type of data required	AAR 2018 (CALLS 2014-2018)[148]
N/A	Participation of RTO[3]s and universities in PPPs (Art. 187 initiatives)	Number of RTOs participating in funded projects and % of the total Number of universities participating in funded projects and % of the total % of budget allocated to RTOs and to universities	182/931 (19.5 %) 130/931 (14 %) RTO: EUR 65 004 472.31 (13.8 %) HES : EUR 31 376 546.38 (6.7 %)
N/A	The objective is to ensure that research projects funded are efficiently compliant with provisions on ethics	% of proposals not granted because of non-compliance with ethical rules/proposals invited to grant (target 0 %); time to ethics clearance (target 45 days)[]	N/A
N/A	Error rate	% of common representative error; % residual error	See section 4.3
N/A	Implementation of ex-post audit results	Number of cases implemented; in total EUR million; of cases implemented/total cases	See section 4.3

ANNEX 7
Scoreboard of KPIs specific to FCH 2 JU

NO	KEY PERFORMANCE INDICATOR	RESULTS
1	Share of the fund allocated to the following research activities: • renewable energy • end-user energy efficiency • smart grids • storage	Renewable energy: EUR 53.4 million (11 %)[152] End-user energy efficiency: EUR 98 million (21 %) Smart grids: EUR 27.2 million (6 %) Storage: EUR 54.8 million (12 %)
2	Demonstrator projects hosted in Member States and regions benefiting from EU structural and investment funds	The FCH 2 JU has made considerable progress towards the KPI of having demonstrator projects hosted in Member States and regions benefiting from EU structural and investment funds[153]: the HyBalance, JIVE, JIVE 2 and DEMOSOFC projects have used additional EU funding schemes in parallel with that of the FCH 2 JU

151 Projects addressing topics related to renewable energy integration (KPI 1) and storage (KPI 4) are interrelated, typically covering both aspects. Complementarily, a common KPI of 23 % is reported for KPIs 1 and 4.

152 https://ec.europa.eu/info/funding-tenders-0/european-structural-and-investment-funds_en
FCH 2 JU projects work mainly with the following funds: European Regional Development Fund (ERDF), European Social Fund (ESF) and Cohesion Fund (CF).

ANNEX 8
Draft annual accounts

BALANCE SHEET

		EUR '000
	31.12.2018	31.12.2017
NON-CURRENT ASSETS		
Intangible assets	43	59
Property, plant and equipment	135	128
Pre-financing	94 697	98 611
	94 875	**98 797**
CURRENT ASSETS		
Pre-financing	83 697	75 200
Exchange receivables and non-exchange recoverables	25 687	25 856
	109 384	**101 056**
TOTAL ASSETS	**204 259**	**199 853**
CURRENT LIABILITIES		
Payables and other liabilities	(67 505)	(86 413)
Accrued charges and deferred income	(71 358)	(56 687)
	(138 862)	**(143 100)**
TOTAL LIABILITIES	**(138 862)**	**(143 100)**
NET ASSETS		
Contribution from members	1 183 489	1 038 217
Accumulated deficit	(981 465)	(870 259)
Economic result for the year	(136 627)	(111 206)
NET ASSETS	**65 397**	**56 753**

STATEMENT OF FINANCIAL PERFORMANCE

		EUR '000
	2018	2017
REVENUE		
Revenue from non-exchange transactions		
Recovery of expenses	4 548	3 778
Other	38	4
Total	4 586	3 782
Revenue from exchange transactions		
Financial income	11	1
Other exchange revenue	251	
Total	**261**	**1**
	4 848	**3 782**
EXPENSES		
Operating costs	(136 465)	(110 156)
Staff costs	(2 900)	(2 760)
Finance costs		(37)
Other expenses	(2 109)	(2 036)
	(141 475)	**(114 988)**
ECONOMIC RESULT FOR THE YEAR	**(136 627)**	**(111 206)**

ANNEX 9
Materiality criteria

The '**materiality**' concept provides the Executive Director with a basis for assessing the importance of the weaknesses/risks identified and thus whether those weaknesses should be subject to a formal reservation to his/her declaration. The same materiality criteria are applicable to the FP7 and H2020 programmes.

When deciding whether or not something is material, **qualitative and quantitative** terms have to be considered.

In **qualitative** terms, when assessing the significance of any weakness, the following factors are taken into account:

- The nature and scope of the weakness;
- The duration of the weakness;
- The existence of compensatory measures (mitigating controls which reduce the impact of the weakness);
- The existence of effective corrective actions to correct the weaknesses (action plans and financial corrections) which have had a measurable impact.

In **quantitative** terms, in order to make a judgement on the significance of a weakness, the potential maximum (financial) impact is quantified.

Whereas the FCH 2 JU control strategy is of a multi-annual nature (i.e. the effectiveness of the JU's control strategy can only be assessed at the end of the programme, when the strategy has been fully implemented and the errors detected have been corrected), the Executive Director is required to sign a declaration of assurance for each financial year. In order to determine whether to qualify his declaration of assurance with a reservation, the effectiveness of the JU's control system has to be assessed, not only for the year of reference, but more importantly, with a multi-annual outlook.

The **control objective** for FCH 2 JU is to ensure that the '**residual error rate**', i.e. the level of errors which remain undetected and uncorrected, does not exceed 2 % by the end of the JU's programme. Progress towards this objective is to be (re)assessed annually, in view of the results of the implementation of the ex-post audit strategy. As long as the residual error rate is not (yet) below 2 % at the end of a reporting year within the programme's life cycle, a reservation would (still) be made. Nevertheless, apart from the residual error rate, the Executive Director may also take into account other management information at his/her disposal to identify the overall impact of a weakness and determine whether or not it leads to a reservation.

If an adequate calculation of the residual error rate is not possible, for reasons not involving control deficiencies, the consequences are to be assessed quantitatively by estimating the likely exposure for the reporting year. The relative impact on the declaration of assurance would then be considered by analysing the available information on qualitative grounds and considering evidence from other sources and areas (e.g. information available on error rates in more experienced organisations with similar risk profiles).

Considering the crucial role of ex-post audits in the JU's control system, its effectiveness needs to check whether the scope and results of these audits are sufficient and adequate to meet the control objectives.

EFFECTIVENESS OF CONTROLS

The **starting point** to determine the effectiveness of the controls in place is the 'representative error rate' expressed as a percentage of errors in favour of the FCH 2 JU detected by ex-post audits measured with respect to the amounts accepted after *ex-ante* controls.

According to the FCH 2 JU ex-post audit strategy approved by the governing board, the representative error rate will be based on the simple average error rate (AER) for a stratified population, from which a representative sample has been drawn according to the following formula:

$$AER\% = \frac{\Sigma\,(err)}{n} = RepER\%$$

Where:

Σ (err) = sum of all individual error rates of the sample (in %). Only those errors in favour of the JU will be taken into consideration.

n = sample size

Second step: calculation of **residual error rate**:

To take into account the impact of the ex-post controls, this error level is to be adjusted by subtracting:

- errors detected and corrected as a result of the implementation of audit conclusions;
- errors corrected as a result of the extrapolation of audit results to non-audited contracts with the same beneficiary.

This results in a residual error rate, which is calculated by using the following formula:

$$ResER\% = \frac{(RepER\% * (P-A) - (RepERsys\% * E)}{P}$$

Where:

ResER% = residual error rate, expressed as a percentage.

RepER% = representative error rate, or error rate detected in the representative sample, in the form of the AER, expressed as a percentage and calculated as described above (AER%).

RepERsys% = systematic portion of the RepER% (the RepER% is composed of complementary portions reflecting the proportion of 'systematic' and 'non-systematic' errors detected) expressed as a percentage.

P = total amount in EUR of the auditable population.

A = total of all audited amounts, expressed in EUR.

E = total non-audited amounts of all audited beneficiaries. This will comprise the total amount, expressed in EUR, of all non-audited validated cost statements for all audited beneficiaries, excluding those for which an extrapolation is ongoing.

This calculation will be performed on a point-in-time basis, i.e. all the figures will be provided as of a certain date.

ANNEX 10
List of acronyms

AAR	Annual Activity Report
APU	Auxiliary power unit
ARES	Advanced REcord System
AWP	Annual Work Plan
BoP	Balance of plant
CA	Commitment appropriations
CAPEX	Capital expenditure
CAS	Common Audit Service
CSAs	Coordination and support actions
CFS	Certificate of Financial Statements
CHP	Combined heat and power
CORDA	Common Research Data Warehouse
COSO	Committee of Sponsoring Organizations of the Treadway Commission
CRS	Common representative sample
CSC	Common Support Centre
DG	Directorate-General
DG RTD	Directorate-General for Research and Innovation
DIGIT	Directorate-General for Informatics
EC	European Commission
ECA	European Court of Auditors
EHSP	European Hydrogen Safety Panel
EU	European Union
EUSEW	European Sustainable Week

FC	Fuel cell
FCEV	Fuel cell electric vehicle
FCH	Fuel cells and hydrogen
FCH 2 JU	Fuel Cells and Hydrogen 2 Joint Undertaking
FP7	European Union's Seventh Framework Programme
FTE	Full-time equivalent
FWC	Framework Contract
g	Gram
GA	Grant agreement
GAP	Grant agreement preparation
GB	Governing Board
H2020	Horizon 2020
HRS	Hydrogen refuelling station
IAC	Internal Audit Capability
IAS	Internal Audit Service
ICF	Internal Control Framework
IG	Industry grouping
IKAA	In-kind contributions in additional activities
IKOP	In-kind contributions in operational activities
IT	Information technology
JRC	Joint Research Centre
JTI	Joint Technology Initiative
kh	Kilowatt hour
KPI	Key performance indicator
kW	kilowatt
kWe	Kilowatt electric
l	Litre

LCA	Life-cycle assessment
MAWP	Multi-Annual Work Programme
mCHP	Micro combined heat and power
MEA	Membrane electrode assembly
MEP	Member of European Parliament
MHV	Material handling vehicles
MGA	Model grant agreement
MoU	Memorandum of Understanding
MW	Megawatt
MWe	Megawatt electric
MWth	Megawatt thermal
NPF	National policy framework
OLAF	European Anti-Fraud Office
PA	Payment appropriations
PO	Programme Office
PEM	Proton exchange membrane
PEMFC	Proton exchange membrane fuel cell
PNR	Pre-normative research
PPP	Public-Private Partnership
PRD	Programme Review Days
RCS	Regulations, Codes and Standards
RG	Research grouping
SC	Scientific Committee of the Fuel Cells and Hydrogen Joint Undertaking
SF	Stakeholder forum
SME	Small and medium-sized enterprise
SOEC	Solid oxide electrolyser cell
SOFC	Solid oxide fuel cell

SRG	States Representatives Group
SSERR	Support Services for Exploitation of Research Results
SWD	Staff Working Document
SYSPER	SYStème de gestion du PERsonnel
TRL	Technology readiness level
TRUST	Technology Reporting Using Structured Templates
TTG	Time To Grant
TTI	Time To Inform
TTP	Time To Pay
TTS	Time To Sign
w	Watt

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