ene.field project

ene.field

Grant agreement No: 303462

Field support reports:
Review of lessons learnt

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Dissemination level: PU

(PU – Public, PP – Restricted to other programme participants, RE – Restricted to a group specified by the consortium, CO – Confidential)

Executive summary

The large-scale market introduction of fuel cell (FC) based micro combined heat and power (micro-CHP) systems in applications such as residential use faces a broad range of challenges, including field support arrangements, which require special attention. This document reports an analysis on field support needs and lessons learnt from the ene.field project, where FC micro-CHP technology was demonstrated in the homes of consumers. It is a supplement to the previously created report on field support arrangements, made within the framework of the ene.field project.

Both FC micro-CHP manufacturers and electricity utility companies were asked about their views and experiences with the subject. This was done in the form of questionnaires as well as a seminar on lessons learnt and future needs.

Manufacturers and utilities alike highlight the need for a proper technical training. A good training reduces installation time and avoids installation errors. Luckily, as this has been a focus for years the tools are already present and used. Training courses and training done internally by the manufacturers are covering the needs present.

Physical size of the technology and site pre-selection are highlighted as issues that require attention. For some potential customers, with high interest in the technology, the installation is not possible because of the size of the system (too high and/or too large footprint). Transport of components inside the house to the site of installation is a problem as well (stairs, doors, etc.) and a good screening of access site to installation is required.

Standardization of grid and gas connection as well as more transparent installation requirements, e.g. chimney connection specifications, would help marked uptake. Partners also point to reduced system size, and the following increased ease of installation, as an important focus for improvement. Offering the customer a complete package, including handling of all paperwork for connection, installation, subsidies among others, is strongly suggested.

Additionally it should be mentioned that the formalities the customer is required to tackle can be daunting. Sales packages including as much help with the paperwork as possible is highly recommended.

About this report

This report is a part of Europe's largest demonstration project for fuel-cell-based micro-CHP (micro combined heat and power) systems, **ene.field** (*European-wide field trials for residential fuel cell micro-CHP*, grant no. 303462). The aim of the project is to demonstrate small stationary fuel cell systems for residential and commercial applications. The project will deploy up to 1000 micro-CHP units in 12 EU member states. This is a steep change in the volume of fuel cell micro-CHP deployment in Europe and an important step to push the technology towards commercialization. The project involves 26 partners. Besides the manufacturers of the FC systems, several research institutes as well as utilities are also involved as partners in the project.

This position paper was written within the framework of the ene.field project.

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1 Introduction

The ene.field project – co-funded by industry and the European Commission's Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) – will place up to 1,000 fuel cell micro combined heat and power systems (FC micro-CHPs) into homes across eleven European countries. The project (which runs from 2012-2017, featuring 26 partners from across the heating and energy industry and €26 million EU funding) is Europe's largest deployment of this modern energy product to date and allows manufacturers to begin to reduce costs due to the volume of units involved.

This document provides an analysis of the lessons learnt and future needs discovered during installation and field support of FC micro-CHPs during the ene.field project.

During the beginning of the project, an evaluation on the current state of the art with regards to field support arrangements, training and certification was performed. The work was carried out in synergy with the JTI-FCH Project Hyprofessionals, focused on vocational training actions. This work draws on two additional European projects (within the Leonardo Program) concerning the development of training courses (H2-Training and H2-Employment). Outcomes of these projects are considered when drawing up the current best practice document.

During the project, the suppliers operating modes have been analysed and continuously compared to highlight best practices to be adopted. Networking activities with the utilities have been performed to understand weak points and barriers with micro-CHP demonstrations.

The preliminary data collected during the ene.field project were presented during a seminar for all of the CHP suppliers and utilities involved in the ene.field project. Results and best practices experienced during the project were presented and collected during an update seminar in September 2015 (during the 3rd annual ene.field project meeting).

A final review of the lessons learnt on training and qualification during ene.field is presented here. Mainly the document reports the experiences of FC micro-CHP manufacturers and electricity utility companies (utilities) during the project: an overview of lessons learnt, best practice and further need for the technology.

The report presents an overview of current status of vocational training in Fuel Cell and Hydrogen field and mainly an identification of EU active courses.

2 Ene.field manufacturers and utilities' collected experience on technicians training

2.1 Methodology

The objective of this section is the collection of information about lessons learnt and future needs: primary aim of this section is the identification of training needs for the people involved in the installation of the CHPs.

Information from the manufacturers and the utilities were first collected using an online questionnaire, shared with the project partners, and a web conference/interview to complete the required information.

Two different questionnaires were prepared by Envipark (EP) with cooperation from the Technical University of Denmark (DTU) for collecting information from manufacturers and utilities.

- One for manufacturers
- One for utilities, in order to collect information about their specific needs

The results and best practices were presented and collected during an update seminar in September 2015 (during the 3rd annual ene.field project meeting); the focus of the workshop was barriers not relating to training.

2.1.1 Manufacturers questionnaire and information collected

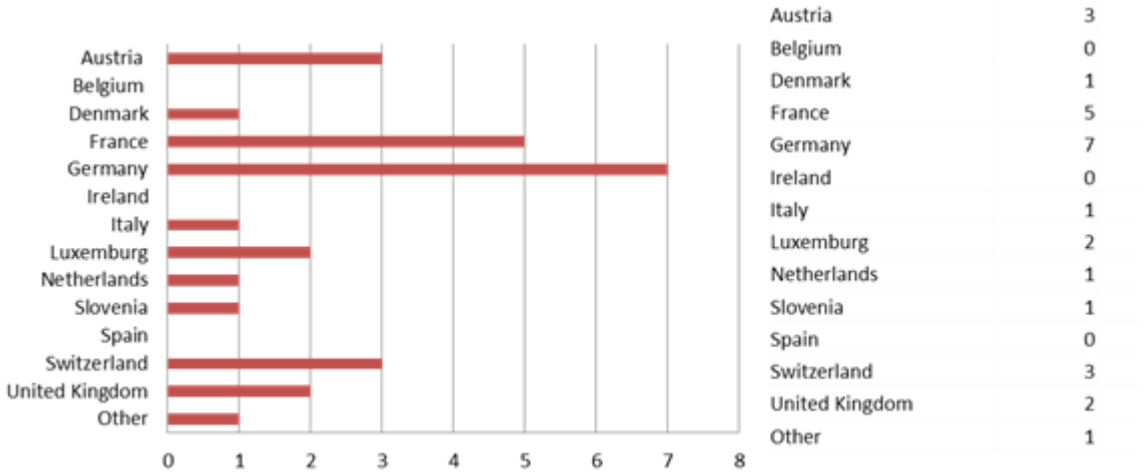
The questionnaire was divided into four topics:

1. General information about the manufacturer
2. Installation process: Specifically installation difficulties and installation time optimisation
3. Training needs: Specifically technician training needs
4. Certification needs

The following sections will discuss the results of the first three sections individually. Certification needs will be discussed in section 2.1.4

2.1.1.1 General information

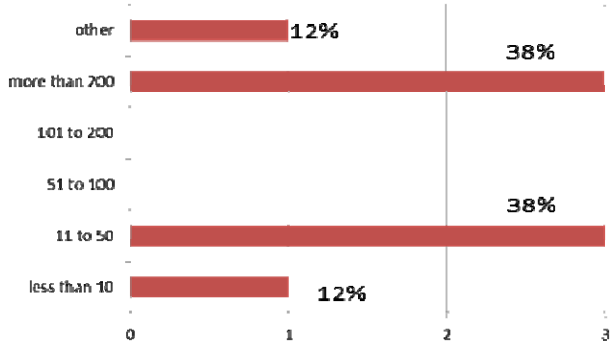
General information: Where do you have installations?



Austria	3
Belgium	0
Denmark	1
France	5
Germany	7
Ireland	0
Italy	1
Luxemburg	2
Netherlands	1
Slovenia	1
Spain	0
Switzerland	3
United Kingdom	2
Other	1

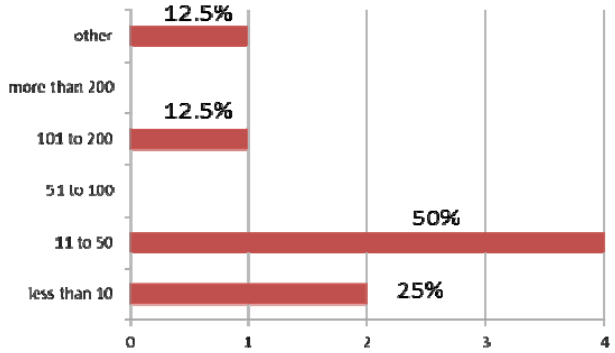
Most of the manufacturers have installations in Germany and/or France. The large number of installations in Germany (7/10 manufacturers have installations in Germany) is mainly due to previous experience on CHP systems developed during Callux Project. After Germany the largest presence was in France (5/10 manufacturers), Switzerland and Austria (3/10 manufacturers).

General information: Number of CHP systems installed before ene.field



Before the ene.field project, 38% of the micro-CHP manufacturers had some experience with installed units (between 11 and 50 systems). The same percentage had extensive experience with installations (more than 200 systems).

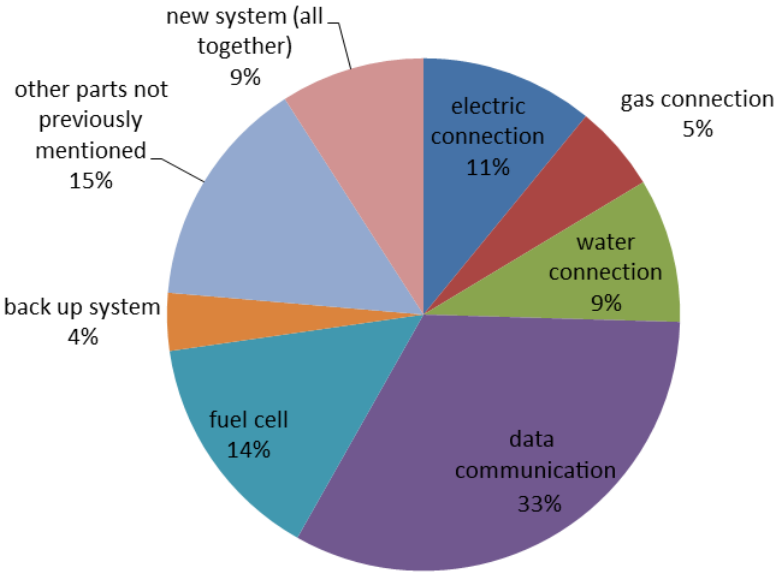
General information: Number of CHP systems installed during ene.field



At the time of polling (August 2015) half of CHPs manufacturers had installed between 11 and 50 systems and a quarter had installed less than 10 units during the ene.field project.

2.1.1.2 Installation process

Installation process: Difficulty of installation



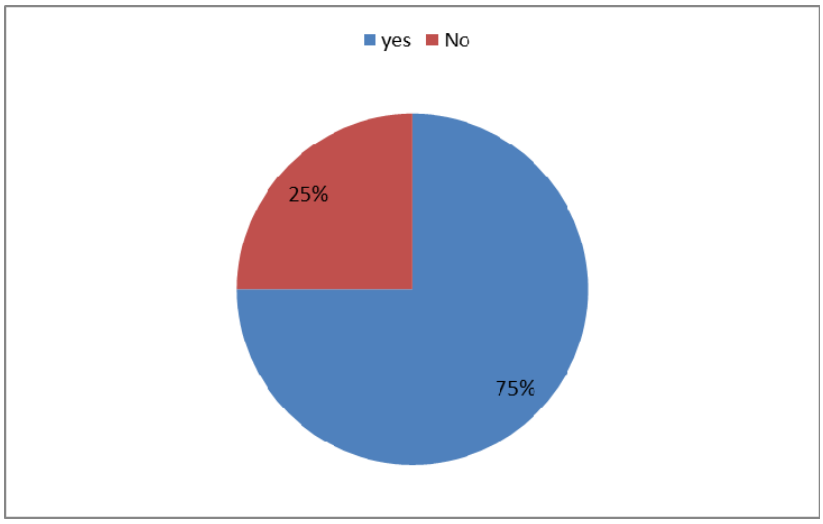
The manufacturers found installation of the FC micro-CHPs in the field mostly straight forward. No component was found more than medium difficult to install. However, some components were overall found more troublesome than others were. Data communication was the part of the installation most commonly rated difficult. Electric, gas and water connections are standard installations for the technical installers and therefore not as prone to difficulty.

A distinction must be made between installation in existing buildings and new buildings.

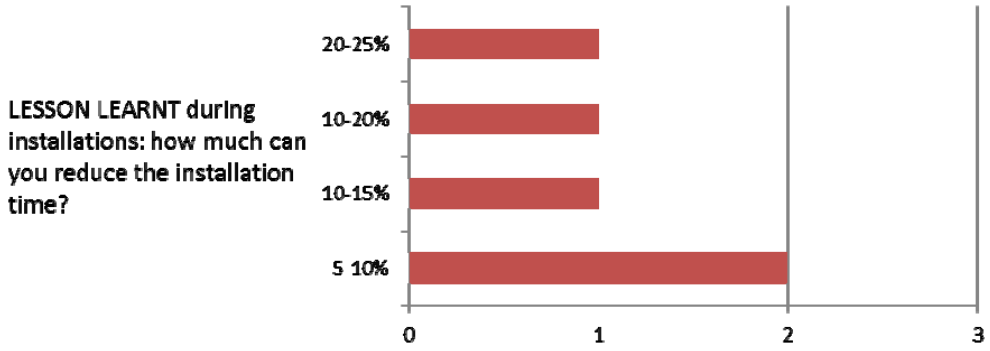
Integration with existing plants and buildings is not always simple and cheap (space requirements, adding components, etc.), mainly because the site preparation required more time than expected from the onset or because of communication and coordination issues between installers, engineers and end-user.

For new building installations, close communication with the building engineers is required, in order to have optimal integration of micro-CHP unit and specific requirements. As this is communication between only two parties, this is generally found to be easier.

Installation process: Can installation time be reduced?



The 75% of the manufacturers expect to be able to optimize the installation process and obtain a reduction of the installation time. Most manufacturers find that the installation time can be improved by between 5% and 25%.



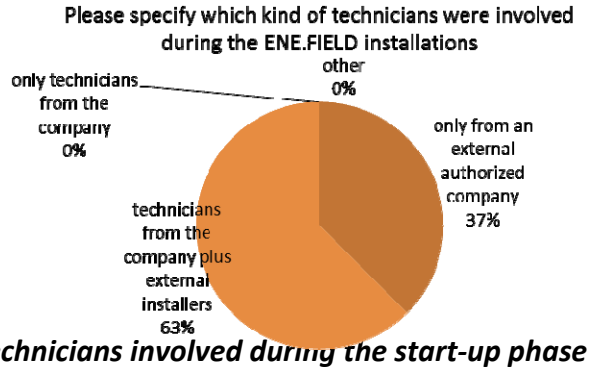
The manufacturers highlight that the installation time is very dependent of the installation site. The most important tool in bringing down the installation time is the gathering of good technical information before the physical installation begins. This requires that well trained professionals are sent to check the conditions of the installation site before installation. The installation process could also be optimized through a careful installation site selection. This is of cause not always possible as site options may be limited.

2.1.1.3 Training needs: technicians training

It is necessary to distinguish between two phases during the installation and start-up of the systems:

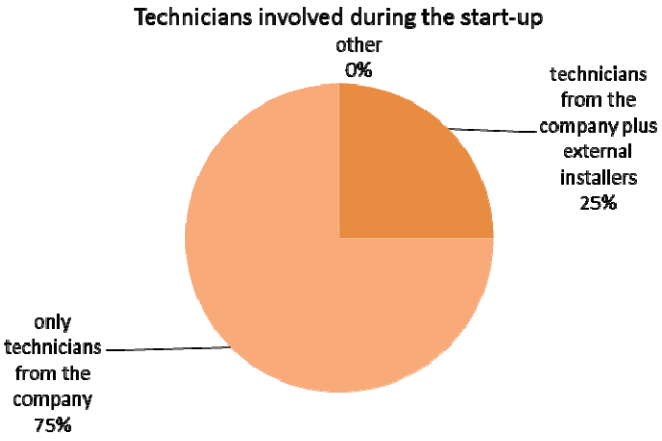
- The initial phase of deployment handled by the company;
- The second phase that will be handled by external parts (external installers, local plumbers, in general local technicians).

Training needs: Technicians involved during the installation phase

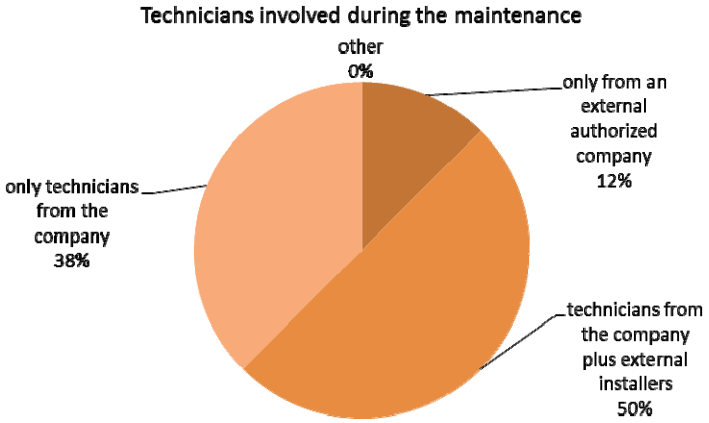


only from an external authorizec company	3	37.5%
technicians from the company p us external installers	5	62.5%
only technicians from the company	0	0%
other	0	0%

Technicians involved during the start-up phase



Technicians involved during the maintenance phase



Technicians for installations: the 63% of CHP manufacturers have technicians from the company and external installers.

Technicians for the startup: the 75% of CHP manufacturers have only technicians from the company

Technicians for the maintenance: the 50% of CHP manufacturers have technicians from the company and external installers; the 38% only technicians from the company.

According to the agreements with the electricity utility companies, technicians involved in the start-up phase can be either internal or external staff; preferably the technicians involved in the maintenance activity are from external companies. The manufacturers certify external staff. The best is working with an external company large enough with experience in micro-CHP systems.

The external company must be able to invest time, money and resources in a learning phase which yields no immediate value.

In this initial phase of FC micro-CHP deployment mainly internal training is used. At later stages it will be necessary to employ external vocational training centres as well.

All manufacturers agree that a good training of installation personnel is crucial. It reduces installation time and avoids installation errors. To ensure the training matches well with the challenge, the manufacturers suggest that the following should be included in the training:

- On national (regional) level, staff should be trained regarding:
  - funding possibilities for the end user (house owner)
  - regulations and procedures for connection to the electric grid.

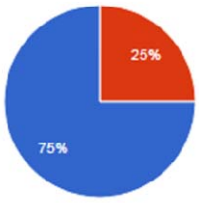
- General information about customer benefit of fuel cells is required in the consulting and planning phase in order to show the end users the advantages of the technology.
- General/basic knowledge about the fuel cell technology, for example about long start up times, in order to avoid errors in handling.

2.1.2 Utilities questionnaire and information collected

In order to access the view of the electricity utility companies on FC micro-CHPs and their large scale marked adoption, the utilities present in the ene.field consortium were asked to fill in a questionnaire on the weak points and barriers with FC micro-CHP introduction.

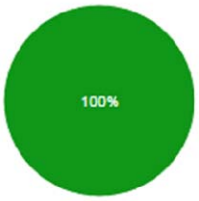
Assessment of the utilities' knowledge of Hydrogen and Fuel cells

Before the ene.field project, did you have any prior knowledge of the fuel cell micro-CHP technology?



Yes	3	75%
No	1	25%

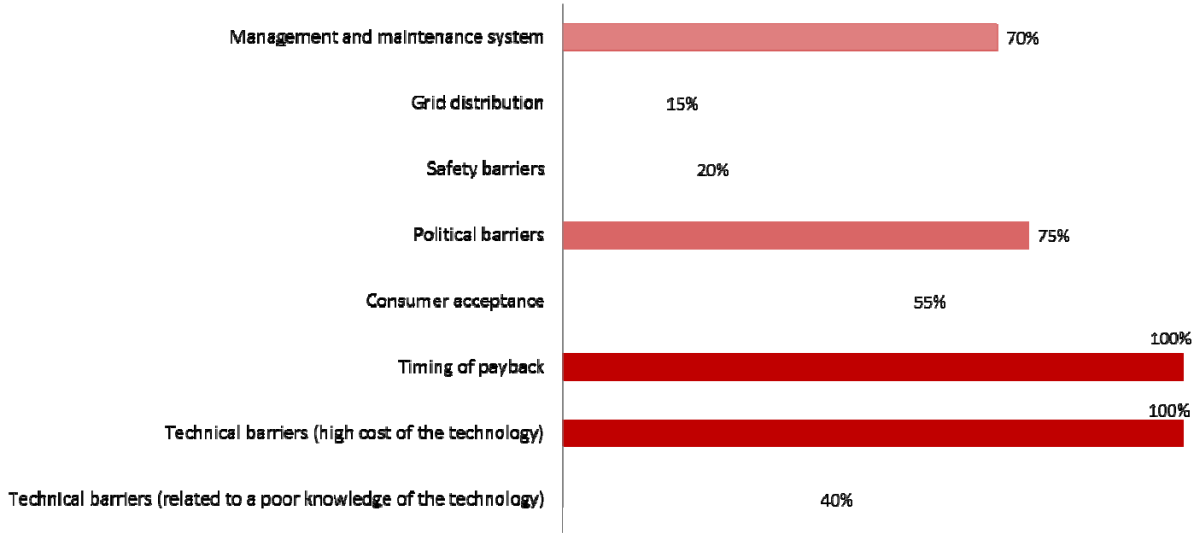
if Yes, through what channels?



National Seminar/workshops	0	0%
Interational Seminar/workshops	0	0%
internet	0	0%
Company Business choice	3	100%
Manufacturer contact	0	0%
Other	0	0%

3 of the 4 utilities in participating in ene.field knew about the micro-CHP technology before the ene.field project, their awareness stemming mainly for company business choices.

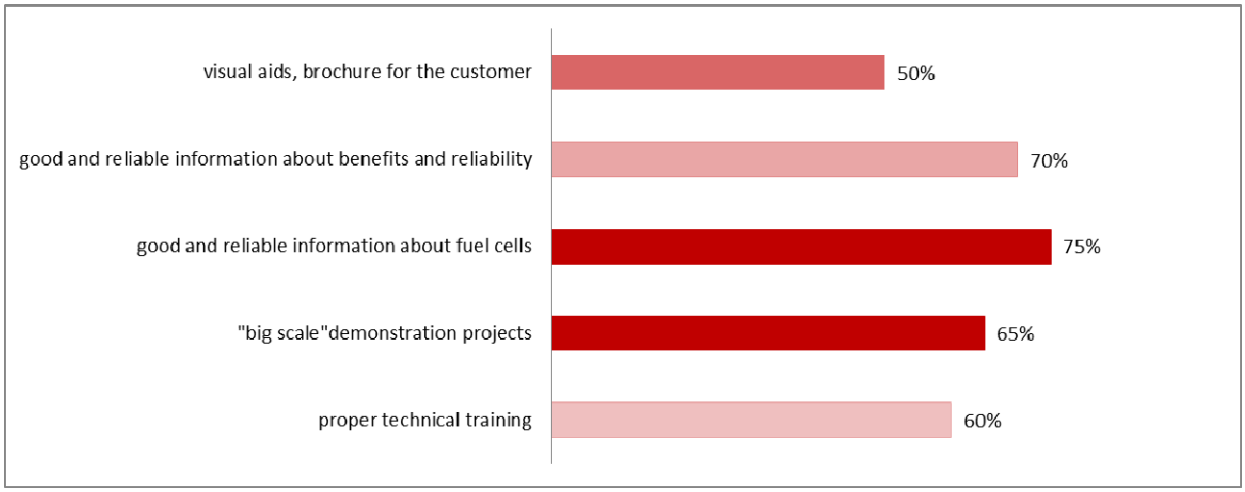
Weak points and barriers with micro-CHP demonstrations as seen by the utilities



The utilities all highlight the cost and the timing of payback as affecting the market introduction of FC micro-CHPs very negatively. Political barriers, management and maintenance system and consumer acceptance follow this. This shows that the economic and political incentives for utilities are not present. One utility highlighted in conversation that a shift in focus has happened, resulting in a need for immediate profitability of investment in new technology.

The high level of bureaucracy related to small scale, non-renewable, co-generation technology and taxes are other crucial points mentioned as barriers for the FC micro-CHP marked introduction. Especially concerns about the administrative and legal structures needed for control of FC micro-CHPs were voiced.

Measures to help the implementation of the technology



The utilities highlighted large-scale demonstration projects, such as ene.field and Callux as an important tool in creating awareness of the FC micro-CHP technology.

Other measures mentioned as helpful for marked introduction technical trainings, information about benefits and reliability of the system, brochure and visual aids for customer.

The utilities responded very favourably to the idea of setting up a centralized demo area in which visitors can see and touch the technologies. Especially if such a demonstration centre is combined with facilities for practical training sessions.

2.1.3 Skill level and implementation

During the workshop in September 2015, at the 3rd annual ene.field project meeting, possible skill shortages were discussed. This discussion was mainly driven by the manufacturers and gave them a chance to share experiences with the field installation process.
A pre-selection of possible installers with combined skills on electrical and hydraulic components was highlighted as necessary. The use of installers versed in multiple aspects of the installation is needed for the installation process to work smoothly. The more personnel needed to cover the installation procedures the higher the risk of failure due to communication breakdown. However, it is only possible to limit the number of individual installers if installers with good knowledges and skills within the fields are available.

Most manufacturers have found that their own organized training of personnel on their specific systems is adequate. However, a dedicated training course might still be beneficial. Such a course should be taught at different levels according to the experience of the installers with a test at the end of the course to determine new qualifications. The training course should involve both practical and theoretical topics but focus on practical sessions.

2.1.4 Information collected during the workshop: other barriers than training

During the workshop in September 2015, at the 3rd annual ene.field project meeting, information regarding the main barriers of the technology were collected and discussed with all the partners of the project. The central activity was an interactive discussion between manufacturers and utilities with the goal of defining what could be implemented to ease the introduction of the FC micro-CHP systems to the market.

Physical size of the technology and site pre-selection were highlighted in the discussion (as well as in the previously discussed questionnaires). For some potential customers, with high interest in the technology, the installation of a system was found to not possible because of the size of the system (too high and/or too large footprint). Transport of components inside the house to the site of installation is a problem as well (stairs, doors, etc.) and a good screening of access site to installation is required.

Apart from reduction of size, the most important point of focus for the manufacturers, when they develop future generations of the technology, is innovations that simplify the installation of the systems. It is highly desirable that the installation procedures and connections are similar as possible to a gas boiler installation.

The above point is not limited to the physical installation of the system. It also relates to the different types of paperwork associated with the installation. Especially the formalities the customer is required to concern themselves with can be daunting. This includes, but is not limited to, formalities such as:

- registration at the grid operator
- approval for electrical measurement
- tax incentives
- subsides for CHP operation
- grant on investment

These are all points the customer expects to receive guidance on and the manufacturers need to be able to help the customer as much as is possible, where possible. Existing processes are too difficult for most end users and a feed-in tariff is not attractive so instruments for micro-CHP stimulation have to put in place. There are restrictions to take into account. There are for instance legal restrictions on who can advise regarding tax issues, something the manufacturers have to keep in mind.

From the manufacturers' point of view, there is a dire need for standardization. This is standardization on all levels, such as Paperwork, installations material, chimney, electrical connection and installation procedures. What drives installation cost up is varying requirements from site to site. One point made by manufacturers installing in Germany is that the requirements for admission of fuel cells by chimneysweepers are not clear.

One specific area in need of standardization is electricity grid connection. European countries each have their own standards (e.g. VDE-AR-N4105, VDE 0126-1-1 and G83-1) and within countries electricity service providers may not have standardized forms and needs nor standardized test requirements. This makes electricity connection a prime focus point in standardization going forward.

The manufacturers also point to the need for commitment from other players, such as energy distributors, facilities, grid managers and authorities. The manufacturers in particular points to the

need for a significant political commitment. This can in part be the recognition of the benefits on environmental and future grid configurations (smart grid, VPP) of the introduction of FC-micro-CHPs.

3 Vocational training across Europe

A detailed walkthrough of the current status of vocational training in Europe can be found in Appendix I. Here is also an overview of active courses within the field.

4 Conclusions

The document reports an analysis on field support needs and lessons learnt from the ene.field project. Manufacturers and utilities alike highlight the need for a proper technical training. A good training reduces installation time and avoids installation errors. Luckily, as this has been a focus for years the tools are already present and used. Training courses and training done internally by the manufacturers are covering the needs present.

Physical size of the system and site pre-selection are highlighted as issues that require attention. For some potential customers, with high interest in the technology, the installation is not possible because of the size of the system (too high and/or too large footprint). Transport of components inside the house to the site of installation is a problem as well (stairs, doors, etc.) and a good screening of access site to installation is required.

Standardization of grid and gas connection as well as more transparent installation requirements, e.g. chimney connection specifications, would help marked uptake. Partners also point to reduced system size, and the following increased ease of installation, as an important focus for improvement. Offering the customer a complete package, including handling of all paperwork for connection, installation, subsidies among others, is strongly suggested.

Additionally it should be mentioned that the formalities the customer is required to tackle can be daunting. Sales packages including as much help with the paperwork as possible is highly recommended.

References

The Assessment Report SET-Plan on Education and Training
https://setis.ec.europa.eu/system/files/SET%20Plan%20Roadmap%20on%20Education%20and%20Training.pdf

HYRESPONSE: European hydrogen emergency response training program for first responders
http://www.hyresponse.eu/index.php

HYFACTS: identification, preparation and dissemination of hydrogen safety facts to Regulators and Public Safety Officials
www.hyfacts.org

KNOWHY: Improving the knowledge in hydrogen and fuel cell technology for technicians and workers.
http://knowhy.eu/

http://www.fuelcellknowhow.com/.
http://www.wbzu.de/veranstaltungen/59/117-Course-Fuel-Cells-and-Hydrogen
http://pureenergycentre.com/contact-us/

Appendix I:

Current status of vocational training in Fuel Cell and Hydrogen field

The fuel cells and hydrogen sector has developed a financial perspective on the joint investment in development and deployment of hydrogen and fuel cell technology up to 2020, in order to gain the necessary progress towards the longer term objectives by 2030 and 2050, which will positively influence the job creation across Europe:

- The European *HyWays* project, funded by the European Commission and aimed at developing a European Hydrogen Energy Roadmap, evaluates in its final report the potential impacts of the development of hydrogen energy in terms of jobs in Europe.
  The report presents three scenarios; the "Optimistic Scenario", obtained with an high policy support, presents that the industry could generate more than 800 000 jobs in Europe by 2020.

- The report *Effects of a Transition to a Hydrogen Economy on Employment in the United States*: Report to Congress, (U.S. DOE, July 2008) presents under the HFI (hydrogen fuel initiative) scenario a "high growth in the light-duty vehicles sector would expand job opportunities beginning around 2020, creating an estimated 680 000 net new jobs by 2035" in the USA, while this figure can reach 110.000 technicians by 2020. The report presents that:

  a) Training and retraining programs may be needed to help ensure that the U.S. workforce possesses appropriate skills and that sufficient numbers of trained personnel are available to meet the manufacturing requirements at the time that hydrogen fuel cell vehicles begin to come off the assembly lines. Development of these programs should involve close coordination between the fuel providers and auto manufacturers, and schools. At the appropriate time, university and vocational programs will need to be assessed to understand where opportunities lie and what additional curricula may be needed.

  b) Training and retraining programs may be useful in related aftermarket areas such as repair and recycling.

c) Educational programs aimed at the general public could help to influence people to pursue jobs in the hydrogen and fuel cells industries.

- *FuelCellToday Industry Review 2010* estimated that the global fuel cell industry could create 700.000 manufacturing jobs by 2020 "The overwhelming majority are in stationary fuel cells, with almost 500,000 total jobs during the next decade. This is commensurate with stationary fuel cells having the largest proportion of MW shipments in this period and a fairly high ratio of jobs to revenue and productivity." About 25% of the jobs, or 175,000 jobs, were projected for North America, but mass manufacturing jobs were expected to go to Asia.

- *The Assessment Report SET-Plan on Education and Training* - Working Group: Fuel Cells and Hydrogen (2012) has evaluate future job perspectives, where a rapid growth of one order of magnitude in workers and technicians is assumed between 2012 and 2020, with emphasis on FCEV, stationary applications and hydrogen production, accounting for thousands of new jobs, while other early markets appear more modest. From 2020 to 2030 it is expected to grow by a factor of 4.

  The SET Plan reports some actions and activities identified as needed following the assessment and recommendations of the stakeholders.

  The Education and Training Network(s) in the Fuel Cells and Hydrogen Field should involve higher education institutions, research and businesses along the fuel cells and hydrogen value chain, covering the different fuel cells, materials and systems, and hydrogen application areas:

  - Renewable hydrogen production (special focus on electrolysis) and storage;

  - Low temperature fuel cells (for instance for applications in transport, for portable devices, etc.);

  - High temperature fuel cells (for instance for applications in power generation, transport, etc.)

  One pilot activity is proposed to kick-start the operation of this advanced network(s): development and implementation of relevant curricula at university level.

The focus of this activity is to develop courses on fuel cell and hydrogen for engineers (mechanical, chemical, electrical, etc.) and scientists (physics, chemistry, etc.). It should provide multi-purpose teaching materials (including simple demonstration equipment) at a range of levels, which can be incorporated in local programs to support local training and education in the area of fuel cells and hydrogen.

The results of the FCH JU project TrainHy-Prof (building training programs for young professionals in the hydrogen and fuel cell field) can be used as a starting point.

- EQF Level: 6-8
- Timeframe for implementation: Year 0+2

https://setis.ec.europa.eu/system/files/SET%20Plan%20Roadmap%20on%20Education%20and%20Training.pdf

The expected rise in employment highlights the need for a well trained work force across Europe, which can cover the new jobs created and therefore, foster FC&H2 technology. The success of a technology is strongly dependent on the level of knowledge of the technicians and workers, as they are the ones who will deal with installation, operation and maintenance. Education now is a critical step towards the widespread acceptance and implementation of FC&H2 technology in the near future. Hence, an initiative that deals with these situations must be created.

Lack of qualified workers and technicians will impede the development of FCH technologies throughout Europe. There is the need of specific trainings, with new offers that must meet the requests of the company.

A company involved in hydrogen installations has to perform installations across the Europe. The same goes for the training.

There is the need of a homogeneous training along the EU Member States.

Outcomes of HyProfessionals and H2Training projects were used for the analysis in the first deliverable; below different educational and training projects and initiatives carried out in Europe during the last years are reported.

Some of these projects and initiatives are:

- **HYRESPONSE: European hydrogen emergency response training program for first responders,** initiated in 2013 in the Topic SP1-JTI-FCH.2012.3.7.

  The core training program is threefold: educational training, including the state-of-the-art knowledge in hydrogen safety, operational training on mock-up real scale hydrogen and fuel cell installations, and innovative virtual reality training reproducing in detail an entire accident scenario, including influence of first responder's intervention. First responders will acquire professional knowledge and skills to contribute to FCH permitting process as approving authority. http://www.hyresponse.eu/index.php

- **HYFACTS**: **identification, preparation and dissemination of hydrogen safety facts to Regulators and Public Safety Officials**. Initiated in 2011, the project aimed to develop and initiate dissemination of training material for Regulators and Public Safety Officials, providing accurate information on the safe and environmentally friendly use of hydrogen as an energy carrier for stationary and transport applications under real conditions. The training material was focused on the fundamental aspects of hydrogen safety and on the safety approaches and criteria developed in standards and according to which hydrogen systems are engineered for the safe use of hydrogen under all circumstances. www.hyfacts.org

- **TRAINHY**: **Building training programs for young professionals in the hydrogen and fuel cell field.** Finished in September 2012, the project contributed to address the training deficit about FC&H2 by devising a system of vocational education and training (VET) for post-graduate engineers and scientists, either at a Masters or PhD studies level of education or already employed by a company. Based on an evaluation of current activities, including the many summer schools and short courses already being offered in Europe, a wider curriculum concept was developed. It offered an interconnected multidisciplinary system of face-to-face and distance learning programs that could be attended in parallel to other studies or professional work. There were two groupings of stakeholders: academic institutions as cooperation partners and industry as end user. They foster the acceptance of the program through different European education systems.

- **KNOWHY**: **Improving the knowledge in hydrogen and fuel cell technology for technicians and workers**. Initiated in 2014 in the Topic of SP1-JTI-FCH.2013.5.2.

Despite the fact that new job opportunities for technicians and workers regarding Hydrogen and Fuel Cells applications are expected to raise in the short term, there is an evident lack of training offers for technicians fitting market demand.

KnowHy intends to overcome this gap offering a program of courses encompassing one common core module and six different specializations. Courses, realized on an e-learning platform, will be held in different countries and available in 7 languages (English, German, French, Italian, Spanish, Portuguese and Dutch).

Partners promote the project among professional associations in Europe with the goal of involving a minimum number of 1000 technicians in a training program foreseeing the following features:

- Specific courses, focused on the applications which are going to enter the market;
- E-learning multilingual platform available in multiple countries;
- Practical training, Serious Games and tutoring to complement the lessons;
- Low cost courses;
- Easily adaptable courses to other languages or new applications, scalable and replicable;
- Self-sustained training based on the establishment of a legal entity in order to continue the training activities beyond the project without subsidies.

http://knowhy.eu/

The course will require approximately 100 hours of student effort, of which there will be 40 hours dedicated to the core module and 60 hours to a specialization module. The contact time will be split between the e-platform and hands on training sessions.

The main modules that will be faced during the project are:

- CORE MODULE, a description of the fuel cell with high attention to safety aspects
- Automotive and Material Handling Sector
- Hydrogen Production and Handling
- Micro Fuel Cells
- CHP and microCHP
- Fuel Cell base Generators (APU and Backup Power)

Short overview of active courses

This session reports an identification of European active courses identified mainly during the Hyprofessionals project.

There are very few educational offerings focused exclusively on the technology of fuel cells and hydrogen. It is common to find references to studies related to hydrogen in chemical technology and some minor references in relation to fuel cells.

Other areas of knowledge where knowledge on fuel cells and hydrogen is incorporated are in studies related to renewable energy. We can find that it appears as an energy carrier and as an alternative to other energy sources. Any approach to this technology represents a small chapter in the whole syllabus of the course.

The other point of view which is interesting to note is the level of education that this type of knowledge offers. Most courses are university level, as free subjects, postgraduate, masters or as part of a given subject. In general, the academic level of courses is aimed at graduates, engineers or equivalent levels.

Clearly, this level of training is essential for the proper implementation and development of a technology. But it is necessary to bring this training to the operational level of implementation to allow the formation of those staff members who will be able to solve and apply all products and installations resulting from the implementation of fuel cell technology.

Currently, UK and Germany are two of EU countries which have shown more acceptance and commitment to FC&H2 technologies.

1. The BTZ Osnabruck is a vocational training-centre. It is part of the chamber of crafts, so their our target groups are at first skilled workers and apprentices, at second other groups as teachers from vocational schools and vocational trainer, but also architects and engineers, who are planning houses and house-heating-systems. They are working together with different CHP-Manufacturers, especially Solidpower, Elcore and Senertec. They also have, belonging on their activities for the German CALLUX-project, a good connection to Hexis, Viessman and Vaillant, so they know the requirements on vocational training for installers.

   In Osnabruck they do only trainings in German language, but they have a partner in Bolzano (Italy), South Tyrol; they have been working together for many years on developing training-offers and –materials for FC-CHP.

They results are blended-learning-courses, comprising two parts: online-learning-modules, containing a thematical overview, special knowledge and the preparation for the second part, a face-to-face-seminar. In the face-to-face-seminar it is possible to work on real fuel-cell-heating-appliances and, especially for understanding the FC-process, work on models. The materials of "ZuHause" are available in German, English and Spain.

The EU-project is called "FC CHP Future". http://www.fuelcellknowhow.com/.

In Italy the project partner lvh.apa (l'associazione degli artigiani dell'Alto Adige) is trying to do several trainings in the first halve of the next year.

They have a similar situation in Glasgow, Scotland. There is another vocational-training-Institute working together with them in FC CHP-Future and offering FC CHP-trainings in English.

The recipients of the Project are:

- Teachers - This category should be trained and shall be familiar with FC heating systems, because they will be the trainers of the future. The recipients are mainly teachers of vocational schools.
- Workforce - The staff must be appropriately qualified: the business owners in order to propose the fuel cell heating units in their area of business, to advice clients and to be able to provide and sell the instruments. The electricians and plumbers should be trained properly in order to plan and implement the installation, operation, maintenance and service related to fuel cell heating units.
- Apprentices - should be trained and prepared on the heating technology with fuel cells to represent the workforce of the future: such as technicians for water-heating systems, such as electronic technicians in the energy sector and construction.

In addition, could be trained: consultants in energy, designers, architects and chimney sweeps.

2. The Education and Training Centre for Innovative Energy Technologies (WBZU) in Ulm, Germany, organize high level education and training programs in the field of new energy technologies, e-Mobility and energy storage. Theoretical knowledge combined with practice and demonstration on Lithium-Ion Batteries, Fuel Cells, Hydrogen and Cogeneration.

Mainly the course on FC and Hydrogen (active in 2016) gives an important introduction to the basics on fuel cell technology and provides by theoretical and practice lessons in four days how fuel cells work, why they offer the potential for high efficiency, and how their unique advantages can best be used. During practical sessions test bench and demonstration units will be used.

Laboratory sessions will be conducted to reinforce important concepts covered during the presentations. The instructors will select a number of laboratory modules for the course. At the laboratories special test benches and demonstration units guarantee a practical training.

The courses are addressed to: Scientists and engineers working in or entering the fuel cell industry; Employees of industries that have recently invested or plan to invest in fuel cell technology; Science and engineering graduate students; Science and engineering faculty whose expertise lie in other fields and are looking to enter

Costs: 1.290 Euro (790 Euro for Students)
http://www.wbzu.de/veranstaltungen/59/117-Course-Fuel-Cells-and-Hydrogen

3. Course on Micro- and Mini-CHP: Installation, maintenance and operation of up to 10 kW of electrical power at WBZU (active in 2016)

   Get to know in this seminar the great potential in the further development of cogeneration by smaller range up to 10 kW of electrical power. Interpretation and application as well as detailed profitability calculations are simulated on the basis of planning software. Practical exercises and demonstrations of on-site equipment will deepen the previously learnt. The main arguments are: basics on CHP, Legal framework, Planning and economy, Practical exercises (two on-site demonstration plants), Installation, maintenance, operation

   This seminar is aimed mainly to craftsmen and designers who want to get an independent overview of the CHP in the lower power range.

   - Craft shops
   - educational institutions
   - Planners, architects and engineers
   - Housing associations / societies

   Costs: 430 €

4. Course on Fuel cells in vehicles and for domestic energy supply: Foundations, state and perspectives at WBZU (active in 2016)

   Fuel cell technology is very versatile. Ranging from the application in vehicles on portable power generator to the house power supply. Due to its high efficiency, the technology helps to conserve resources and sets when using "clean" hydrogen produced neither CO2 nor air pollutant free. With natural gas-powered plants exhibit excellent emission values. In certain market segments, for example, as generators or UPS, fuel cells are already available on the market. In the automotive sector are currently large-scale and promising field trials in the testing phase. In the domestic energy supply, there are already competing systems.

   In this seminar you will get in addition to mediating the electrochemical fundamentals and thermodynamic contexts a comprehensive overview of the state of the art, the application fields and the economic potential of these technologies.

   An in-house pilot plants and test benches You will then receive a practical insight into operational performance and applications of fuel cells.

   Topics:

   - Fundamentals for fuel cell and hydrogen technology
   - Fields of application and markets
   - Demonstration (visit fuel cell propulsion system, uninterruptible power supply with fuel cells, fuel cell CHP training

   Target group:

   - Experts and managers from the automotive industry
   - Educational institutions, teachers and lecturers
   - Plant, heating and small appliances
   - Authorities, municipalities and organizations
   - Automotive, SHK and electrical trades
   - Start up's

   Costs: 430 €

5. The Pure Energy Center (UK) offers several different training courses:
   - Fuel Cell Technologies training course
   - Hydrogen Technologies training course

- Wind Generation training course
- Solar Photovoltaic training course
- Nitrogen training Course

http://pureenergycentre.com/contact-us/

There are very few institutions in the UK offering training activities specific to hydrogen and Fuel Cell, other than Universities .The only specific H2 and Fuel Cell organization that delivers H2 and Fuel Cell training is the Pure Energy Centre based in the Shetland, Scotland. These tend to be short non- university courses of 1-5 days in duration.