HYPROFESSIONALS

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Report on the development of selected training initiatives in the field of Hydrogen and Fuel Cells

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1 Objectives of the report

The objective of this report is to review the proposals and initiatives from deliverable D9 which have been identified by the projects consortium partners and to look at ways that a number of these could be implemented into pilot actions.

This will be achieved by first of all reviewing some important data from deliverable D8 ‘Gap Analysis’ and deliverable D9 ‘Specific proposals/initiatives developed report’

From D8 ‘Gap Analysis’ specific answers to questions from industry and academia which has important implications towards specific proposals/initiatives (training)

The decision to focus attention on the ‘vocational’ technician training sector as opposed to college/university degree/PhD courses and also short, professional and potentially internal training courses.

As part of the development of pilot action training it is vitally important to look at the current methods of training in order to ascertain the most appropriate mode of delivery it is also worth reviewing any potential new methods of training and this report briefly highlights a number of these such as Just in time training which uses the current technology of smart phones and computer tablets, Interactive training, M-Learning and Gamification.

Training also differs with the actual subject material, technical based subjects such as fuel cells, mathematics, chemistry, physics etc may require different modes of delivery from non technical subjects such as history, geography etc. A number of training modes are considered appropriate for the training of technically based subjects, these include E-Learning, Train the Trainer and Vocational Education Training (VET).

Finally from the partner proposals and in conjunction with the 6 identified potential proposal descriptions, four pilot actions were identified to be carried out.

2 Method used

For this report important information was taken from the previous deliverables D8 ‘Gap Analysis’ and D9 ‘Specific proposals/initiatives developed report’.

As outlined in Deliverable D8, an external questionnaire was distributed to a number of educational and industrial organisations in order to find out their training requirements.

As outlined in Deliverable D9, specific proposals/initiatives were obtained from the partners collected using a partner ‘on-line questionnaire’, and shared with all partners. The questionnaire was designed by– ENVIRONMENT PARK with a strong contribution from Foundation for Hydrogen in Aragon, as project coordinator.

All partners were asked to contribute and describe some specific proposals/initiatives and then the collected material was processed and merged and detailed in this document D9.

The outcomes from this document (D9) are discussed in greater detail in this deliverable report D10, specifically those which are considered to be feasible and steps required in order to implement them.

Proposals and initiatives highlighted and reviewed in D9 originated from the following partner countries:

- International Centre for Hydrogen (UNIDO ICHET) – Turkey
- Centre for Process Innovation (CPI) – UK
- Environment Park (EnvPark) – Italy
- Foundation for Hydrogen in Aragon (FHa) – Spain
- EU Commission Directorate General Joint Research Centre (JRC) – Belgium
- Weiterbildungszentrum Brennstoffzelle (WBZU) – Germany
- Association Phyrenees (PHyR) - France

3 Important findings from deliverables D8 ‘Gap Analysis’ and D9 ‘Specific proposals/initiatives developed’

Information obtained from the project deliverables D8 ‘Gap Analysis’ and D9 ‘Specific proposals/initiatives developed’ form the basis of this report on the review and implementation of specific proposals and initiatives for the vocational training of technicians in Hydrogen and Fuel Cells within the EU.

From the report D6 data was collected from 129 (57 academia and 72 from industry) stakeholders from 13 countries within Industry, Academia (Education) and Institutes (Foundations, Associations) via questionnaires (including telephone questionnaires). Of notable interest are the responses to many of these questions and they reflect the direction in which the training should focus on and in conjunction with the proposed proposals and initiatives within hydrogen and fuel cells.

Academia

Country	Total
Austria	1
Belgium	2
Bulgaria	1
Denmark	1
France	6
Germany	15
Hungary	1
Italy	11
Romania	1
Spain	14
Turkey	2
United Kingdom	2
Total	**57**

Industry

Country	Total
Austria	1
Denmark	1
France	9
Germany	18
Italy	15
Netherlands	2
Spain	15
Turkey	3
United Kingdom	8
Total	**72**

A summary of the relevant outcomes from D6 are:

From academia

- Education centres appear to have a relationship with companies (industry) however these seem to be limited.
- Education centres appear to have a good base in Hydrogen courses.

From Industry

There were a number of questions asked in which the responses were of interest:

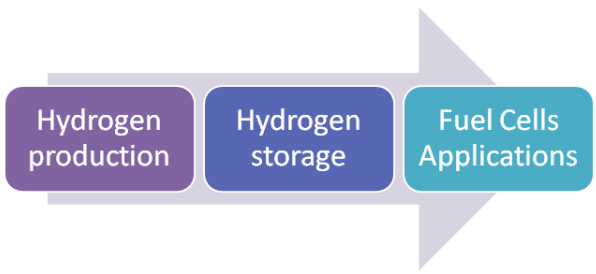
- Is it easy to find qualified (assuming within the areas of Hydrogen & Fuel Cells) workers?; 59% replied No
- Does the company need to train technicians for Hydrogen & Fuel Cells related activities (i.e. **Internal training**)?; 59% replied Yes
- Does the company need to train technicians for Hydrogen & Fuel Cells related activities (**Short Professional training**)?; 56% replied Yes
- Does the company need to train technicians for Hydrogen & Fuel Cells related activities (**Short Theoretical courses**)?; 47% replied Yes
- Does the company need to train technicians for Hydrogen & Fuel Cells related activities (**Long Formal University courses**)?; 66% replied No.
- Does the company need to train technicians for Hydrogen & Fuel Cells related activities (**Long Formal Training Centres**)?; 70% replied No

The Industry based questionnaire also highlighted that the specific training area for Hydrogen and Fuel Cells was in the areas of Technical (hydrogen production, storage & fuel cell applications) and Regulatory/Security also and important with respect to HyProfessional is that the level of training should focus towards the technician and engineer level employee (with 64% and 84% saying yes to these areas).

It is acknowledged that the questionnaires (both to Industry and Academia) are a relatively small sample size and not scientifically accurate, however they do highlight a number of areas in which is important when we look at the needs of industry for the training in hydrogen and fuel cells namely that they should be relatively short courses, ideally internal to the organisation and targeted at the technician/engineer level employee, this therefore provides some evidence for this project that one of the most important areas to target future training initiative on are for those employees who will be required to manufacture, install and service these technologies in the future.

With that in mind it is extremely important to identify potential initiative and proposals in order to train these important sectors.

Deliverable D9 ‘Specific proposals/Initiatives developed report’ highlighted the sectors within fuel cells (such as portable, stationary, transport etc) that are currently developing commercially such as fork-lift trucks, auxiliary power etc and also the production, storage and distribution of hydrogen which is already regularly used in many industrial sectors such as the production of chemical and is also somewhat related to the renewable energy market which is growing significantly. This overlap is in itself a strong driving force for the development of the sector.



As stated in D9 training initiatives/proposals should take into account this important relationship between fuel cells and renewable energy.

From the partner proposals (23) the following six areas were suggested as potential target areas for the developing of pilot actions.

Proposal description
E-Learning material on basic fuel cell and hydrogen technologies
Developing hydrogen & fuel cell education syllabus and curriculum
Training action focused to introduce safety knowledge and hydrogen manipulation
Training action focused to maintain the demonstrative projects from the JTI
Training action focused to introduce fuel cell technology applied on cars
Training action focused to introduce fuel cell technology applied on early market installations: UPS (Uninterruptible Power Supply) and relative devices, Forklifts and CHP

4 Current modes of training

Before specific proposal/initiatives are discussed it is important to briefly review the current modes of training available. This is not an exhaustive list however it highlights some of the many ways in which to train individual and groups.

Different types of training requirements call for different types of training delivery. Some common modes of delivery are classroom-based Instructor-led training, Virtual Instructor-Led Training, Video Learning System, Computer-Based Training and Web-based training.

4.1 Instructor-Led Training (ILT)

Instructor-led training or ILT is the practice of training given by an instructor, typically to a group. Instructors can also be referred to as facilitators, who may be knowledgeable and well-versed with the learning material, but can also bring more of their coaching, facilitation, and mentoring skills to deliver training to learners, this is best for concept and skills training. Instructor-led training includes **Training the Trainer** which is designed to introduce new and experienced trainers to fresh methods for creating and managing effective training programs that truly engage their learners. Training can be expensive and time-consuming to give to an entire team therefore this type of training is intended for those from organisations who are themselves training others, it provides a cost effective and focussed way of training multiple people who can then pass on the knowledge gained to others.

4.2 Virtual Instructor-Led Training (VILT)

Virtual Instructor-Led Training blends the qualities of Instructor-Led classroom training with the convenience of a virtual, online classroom. Training is achieved via an easy-to-use web application. Classes include lectures, demonstrations and hand-on labs taught by highly-qualified and experienced instructors.

Best for:

- Basic training
- As a component of ILT
- Facts, procedures, or basic skills training

4.3 Video Learning

Video is one of the most popular audiovisual media to be used in training. It can be used in place of an ILT. Using a video in a training session requires careful planning to ensure that it is used to its best effect. Best suited for informational, motivational, and procedural content or if motion is required to teach content (exercise videos; driver's education).

4.4 Computer-based Training (CBT)

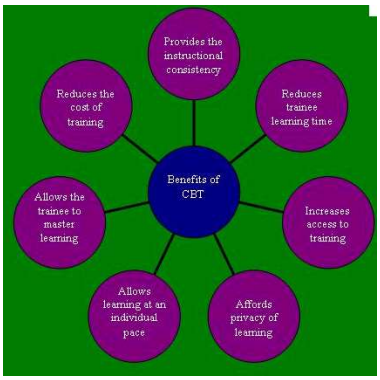
Computer Based Training (CBT) or Computer Assisted Instruction or Tutorials refer to any instruction delivered through a computer. A CBT course can be delivered through specific software installed on a single computer, through CD ROM, or through a corporate or educational intranet. Best suited for Subjects in which elaborate multimedia elements are required to facilitate learning.

4.5 Web-based Training (WBT) or E-Learning

Web-based training (WBT) refers to CBT delivered over the Internet. It can be delivered anytime in any part of the globe to anyone with Internet access. This has grown into something with immense possibilities, and comprises a world of skill improvement, enhancement of learning and understanding, and changing attitudes and behaviours over a period of time.

Best Suited for:

- When the learners are globally scattered
- Where the content requires frequent updates



Benefits of Computer based training

5 Developments in training techniques

5.1 Implement Just-in-Time Training (use of Smart phones, tablets)

All trainers know that the best way to learn something is by doing it. That's what just-in-time training enables people to do rather than sit in a classroom and learn, people learn in real time. Remember, most employees have a multimedia computer with them at all times (their phones or tablet). With just-in-time training, they can access any element of what they need to know at the moment of need. If they have a question or need assistance, they simply touch an icon on their device's screen and are connected to a live trainer who can help. If the trainer needs to see something to give assistance, the employee can aim the device's built-in camera at the problem so the trainer can see it. This alone would cut training costs tremendously.

Does this mean we eliminate classroom training? No. There will still be classroom training, but less of it because now we can have distributed training in real time that is just in time. So this isn't about getting rid of something; it's about using a new tool for training and education.

5.2 Create Interactive Training Materials

There is now the ability to create interactive training manuals and textbooks. In the past, e-books have been static, basically an electronic PDF of the book. Now they are becoming dynamic e-books where you have embedded audio, video, and links to other resources. And thanks to visual communications, you can even have a way for employees to tap a special button in the training manual and be connected to someone who can give more advanced training on a specific subject.

Additionally, employees can tap into a series of videos that allows them to personalise the training for their specific needs. Since the training manual is no longer static, employees can personalise the manual by plugging into a menu of more advanced training options embedded within.

5.3 M-Learning

With new technologies enabling a wider use of on-demand learning, mobile learning is standing in the wings waiting for its moment to shine. In its purest form, mobile learning (m-learning) is micro learning: training delivered via a mobile device such as a Smartphone, MP3 player, netbook, Kindle, or iPad. M-learning is also predicted to be one of the top trends in learning.

5.4 Gamification for Training and Education

Gaming is not just for children, interactive gaming is a tool that can transform training and education. Five core elements of gamification for accelerated learning have been identified:

1. **Self-diagnostic.** Interactive, competitive, and immersed training modules can know each person's skill or knowledge level and progress accordingly. It can know where someone left off and give next steps from that point when the person logs back in. This is the best way to allow for individual training and learning.
2. **Interactivity.** Regardless of someone's inherent learning style, learning is much more effective when you're interacting with the material, not passively sitting there. When you learn by gaming, you're interacting with the information and concepts and actually doing things. It is no longer passive training.
3. **Immersion.** In the recent past to the present, video games use interspatial 3-D, where you go into worlds. Therefore instead of images popping out at you, you actually go inside them. That's how games on the Xbox 360 and others have been working for years, by using a regular television set or flat panel display. This sort of technology gives an immersed effect, which engages people more.

4. **Competition.** Humans are naturally competitive beings. When you're sitting in class learning, there's little competitive value. No one advances until the class is over. However, when you're competing, as in a game, there is an adrenaline rush that keeps you engaged and focused on the task at hand.
5. **Focus.** Focus is the result of interactivity, competition, immersion, and self-diagnosis. When you can focus, you can learn virtually anything….fast.

6 Training methods for technically based subjects

Technology training can be a difficult task because each end user has a different skills set, learning style, has his own learning style, and brings various barriers to learning to a training session. Some people are intimidated by technology while others resist learning it because they do not see a need for it. These are the various challenges facing technology trainers, who must be prepared with a training plan that reaches each member of a target audience.

It's important for every trainer and teacher, even those teaching topics other than technology, to recognise that everyone has a different learning style. Some prefer lectures wherein the trainer speaks on the topic while the audience listens and asks questions. Others prefer some lecture with a chance to work hands-on with the technology while the trainer is present, so they can ask questions if they run into problems. Finally, others like to be directed to resources that they can review completely on their own. Technology trainers must take these various styles into consideration when creating a trainer plan so that they can be most effective.

6.1 E-Learning

From an organisations point of view, greater emphasis is being placed on cost savings and on flexible, just-in-time education and training, to provide employees with the necessary skills and competence that match changing business needs. Owing to the transitional nature of the hydrogen economy, the continual introduction of new technologies, and the consequential rapid diversification of the skill-set sought by employers, E-learning is expected to become important in providing education and training in hydrogen safety. Because E-learning does not confine trainees to a specific campus location, employees are given maximal opportunity to acquire new skills and competencies while continuing in full-time employment, and to maintain family and domestic commitments. Moreover, E-learning makes it possible for experts working at the forefront of hydrogen safety to deliver teaching on the state-of-the-art in the field, while continuing their research of scientific endeavour.

6.2 Vocational Education Training (VET)

The potential of vocational training to support or even drive competitiveness, innovation and growth policies has largely been neglected in education and training policies, in particular when compared with the role attributed to the higher education sector. This neglect is harmful as it underestimates the crucial importance of high volume and high quality VET for retaining and developing the economy.

Better vocational education is vital if Europe is to respond adequately to its challenges of global competition, high numbers of low-skilled workers and young unemployed, and ageing populations.

A review of vocational education and training (VET) requires some definition that distinguishes the various terms and concepts used to depict this very complex level of education. Many terms describe one or more elements of what may be conceived as comprising VET. Terms commonly used in different contexts and countries include:

- Apprenticeship programmes;
- Vocational education;
- Technical education, or technical and vocational education and training (TVET);
- Occupational education (OE);
- Career and technical education (CTE);
- Workforce or workplace education (WE) and workforce development (WD).

An education that prepares people for specific trades, crafts and careers at various levels from a trade, a craft, technician, or a professional position in engineering, accountancy, nursing, medicine, and other healing arts, architecture, pharmacy, law etc. Craft vocations are usually based on manual or practical activities, traditionally non-academic, related to a specific trade, occupation, or *vocation*. It is sometimes referred to as *technical education* as the trainee directly develops expertise in a particular group of techniques.

7 Appropriate proposals for Pilot Actions

Based on the information obtained from deliverables D8 and D9 and specifically the six highlighted proposal areas which should be targeted for training, the following 4 pilot actions have been identified:

7.1. UNIDO ICHET proposal (Turkey)

UNIDO ICHET is particularly focused in the role of education for the implementation of a hydrogen inclusive economy. ICHET is proposing short training courses and workshops to graduate students, academics and government agencies about hydrogen technologies, hydrogen production, storage, safety, fuel cell technologies and system integration.

What ICHET proposes is to develop a Hydrogen & Fuel Cell Education Syllabus and Curriculum with training materials for hydrogen & fuel cell technicians to get theoretical and hands-on knowledge.
Proposals can be specific to educate technicians or newly graduate engineers. Instead of one centralised location to train people, every location should manage training centres locally.

Objectives include:

- Principles of electrochemistry & hydrogen
- Hydrogen production, storage, distribution and utilisation technologies
- Laboratory experience with hydrogen and fuel cell technology
- Equipment, vehicles and their integration

7.2. Environment Park proposal (Italy)

Vocational training in Italy is mainly the responsibility of the Regions: the scholar path is parallel but in some way different from schooling, directed by the National Ministry of Instruction. In Italy the vocational training centres provide 2-3 years of study with a prevalence of practical subjects specialised in the sector in order to achieve a professional qualification.

An important contribution to vocational training is also provided by private training institutions offering specialised training content on specific areas of professional learning. Many courses offered by private institutions are free of charge as they are financed from the resources of the EU European Social Fund.

Environment Park is a testing laboratory, but was sometimes we were involved in training courses concerning the whole hydrogen chain: production, storage and application. Courses were based on theory and practical activities (for example: test of a 10 kWe natural gas reformer, test of fuel cells stack). Training courses were somehow “general purpose”, addressing technical staff from industry and teachers of every school.

What Environment Park proposes is:

- Establish training courses based on theory and practical activities in laboratory to create a real physical contact with the Fuel Cell technology.
- Develop training courses for technicians involved in early market installations to facilitate hydrogen infrastructure installation and spread. This activity could involve early market application manufacturers such as UPS, Forklift and portable application. Also microCHP manufacturers should be included.

Objectives include:

- Broadcast the basic principles in terms of hydrogen (production, distribution & storage)
- Explore opportunities in hydrogen technologies
- Show practical safety issues of hydrogen handling
- Transmit a close connection between research and applications

7.3. WBZU proposal (Germany)

WBZU provides high level education and training in the fields of Fuel Cells, Hydrogen, Batteries and Combined Heat and Power is the society's key task. WBZU provides unbiased information for decision makers in politics and industry as well as general information of the public on these technologies and their application potential.

What WBZU proposes is a workshop about Fuel Cells and Hydrogen, and would be based on the WBZU current course ‘Polymer Electrolyte Fuel Cell’. The Polymer Electrolyte Fuel Cell (PEFC) and Hydrogen Technologies course will give a detailed introduction in PEFC and hydrogen technologies, showing the state of art of development, potential technology bottlenecks and suggested research and development directions. Also the course will deal with the relevant safety aspects which occur with the utilisation of hydrogen.

Objectives include:

- Basics and fundamentals of PEFC and Hydrogen technologies
- Polymer Electrolyte Fuel Cell applications
- Hydrogen system and infrastructure
- Hydrogen handling safety aspects

7.4. FHa proposal (Spain)

FHa promotes education in hydrogen technologies in order to train professionals in this sector. The Foundation organises conferences and seminars along the year and collaborates with universities and educational centres in training activities.

What FHa proposes is the use of an E Learning package together with attendance for one full day at FHa for practical tuition. The main advantage of this mode of training is the opportunity to train a large number of students in a more convenient timescale to suit the student. To support this, the one day attendance at FHa for practical training would reinforce this E Learning training.

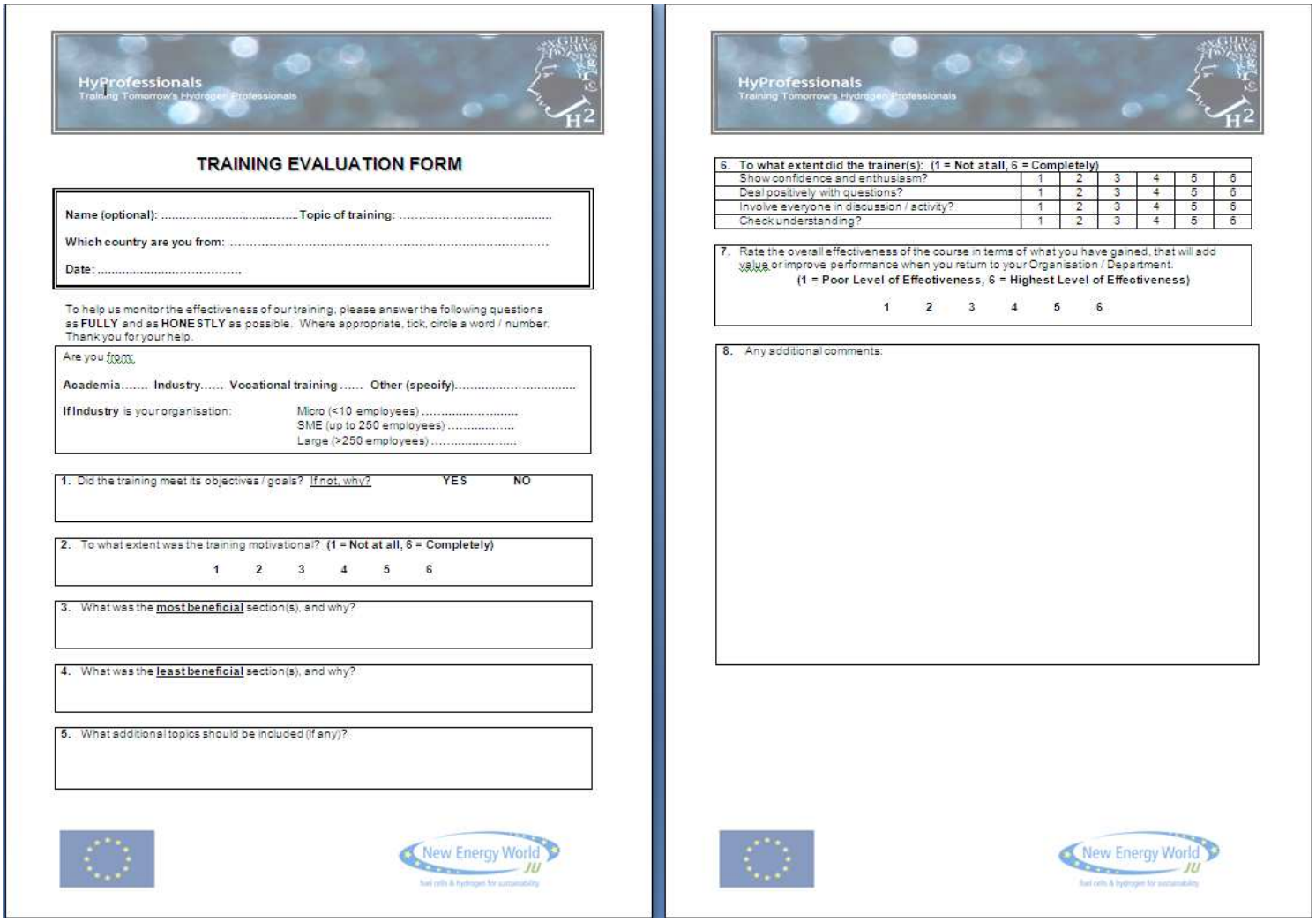
Objectives include:

- Understanding the basic principles in terms of hydrogen (production, distribution and storage)
- Teach the general concepts of architecture and components of Fuel Cell Electric Vehicles (FCEV)
- Acquire the knowledge necessary for the maintenance and repair of FCEV
- Establish basic knowledge in hydrogen and high voltage safety

7.5 Capturing the feedback and learning from the Pilot Actions

For the pilot actions it was important to obtain feedback from these, therefore a feedback form template was designed with the option to translate into the appropriate pilot action course language.

Feedback Questionnaire template.



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TRAINING EVALUATION FORM

Name (optional): ..... Topic of training: .....

Which country are you from: .....

Date: .....

To help us monitor the effectiveness of our training, please answer the following questions as **FULLY** and as **HONESTLY** as possible. Where appropriate, tick, circle a word / number. Thank you for your help.

Are you from:

Academia..... **Industry**..... **Vocational training**..... **Other (specify)**.....

If Industry is your organisation: Micro (<10 employees) .....
SME (up to 250 employees) .....
Large (>250 employees) .....

1. Did the training meet its objectives / goals? If not, why? YES NO

2. To what extent was the training motivational? **(1 = Not at all, 6 = Completely)**

1 2 3 4 5 6

3. What was the **most beneficial** section(s), and why?

4. What was the **least beneficial** section(s), and why?

5. What additional topics should be included (if any)?

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6. To what extent did the trainer(s): (1 = Not at all, 6 = Completely)						
Show confidence and enthusiasm?	1	2	3	4	5	6
Deal positively with questions?	1	2	3	4	5	6
Involve everyone in discussion / activity?	1	2	3	4	5	6
Check understanding?	1	2	3	4	5	6

7. Rate the overall effectiveness of the course in terms of what you have gained, that will add value or improve performance when you return to your Organisation / Department.
(1 = Poor Level of Effectiveness, 6 = Highest Level of Effectiveness)

1 2 3 4 5 6

8. Any additional comments:

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7 Conclusions

This report has highlighted a number of important issues and opportunities from previous project reports, namely D8 ‘Gap Analysis’ and D9 ‘Specific proposals/initiatives developed’. From these it was shown that there is a growing requirement for professional, short course training on Hydrogen and Fuel Cell technologies.

With that in mind there are numerous ways of delivering training and careful choices should be made when developing training regimes. This is especially the case when training involves technically based subject areas such as Chemistry, Physics, Mathematics, Engineering etc.

Face to face training such as ‘instructor-led-training’, ‘train the trainer’ etc provide opportunities for one to many training of students; this has the advantage of practical training which is often part of technically based subject areas. The main disadvantage of this is that it requires students to ‘physically attend’ a specific location at a specific time and over a specific timescale therefore limiting the number of students which can be trained.

Information Technology/Computer/Video based training such as Computer Based Learning; E-Learning has the advantage of being able to train students in large numbers and at a more convenient time of choosing. The disadvantage of this training method with respect to technically based subjects is the lack of any practical training etc. That said if computer based training is supplemented with a practical element then this provides a much more balanced form of training.

It is important to review and potentially embrace ‘new routes’ to training. The increasing power and accessibility of Smartphone’s, tablets etc have provided new ways of delivering training especially to the younger generation who use this on a day to day basis.

In summary there are many ways in which to deliver training on Hydrogen & Fuel Cells and therefore careful thought should be given to the target audience, questions should be asked such as, what is to be achieved from the training and over what time period.

For the HyProfessionals project a number of proposals and initiatives were put forward by the projects partners. From these four pilot actions were selected and these included many of the comments made above, namely face-to-face training, E-Learning and a combination of both.