Co-funded by the European Union

UPHYMOB

Definition of UpHyMob learning outcomes based on skills needs analysis

Result type: R1 – T4

FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN (FHa)

October 2022

Project details

Project acronym:	UpHyMob
Project name:	UpHyMob
Project code:	2021-1-ES01-KA220-VET-000028038

Document Information

Document ID name:	UpHyMob_RE_Definition of UpHyMob learning outcomes_2022-10-20
Document title:	Definition of UpHyMob learning outcomes based on skills needs analysis
Output Type:	Result
Date of Delivery:	20/10/22
Activity type:	Result
Activity leader:	FHa
Dissemination level:	Public

Document History

Versions	Date	Changes	Type of change	Delivered by
Version 1.0	20/10/2022	Initial document	-	FHa
Version 2.0	22/11/2022	Changes to address PROMEA's notes	Fine-tuning	FHa
Version 3.0	20/01/2023	Changes to address IST's notes	Fine-tuning	FHa

Disclaimer

TABLE OF CONTENTS

1 INTRODUCTION

Hydrogen is foreseen to play a big role in the global decarbonization goals. In this sense, the European Commission already accounts with an ambitious hydrogen strategy, with the goal of reaching a steady production of renewable hydrogen in the short-term, investing heavily in the mobility sector. In fact, Hydrogen Europe expects 10.000 hydrogen trucks on Europe's roads by 2025 and 100.000 by 2030. In order to support the movement towards a hydrogen-based transport sector, there is a pressing need for a workforce (namely technicians to be employed in the sector) with a specific set of skills, such as vehicle parts ordering and inventory management, vehicle instrumentation, diagnosis and repair of H_2 power-trains, installation and maintenance of Hydrogen Refueling Stations, following protocol for refueling H_2 vehicles. Therefore, upskilling of the workforce is of vital importance and is the only way to avoid unemployment by the imminent shift to a green mobility sector. Indeed, it is strongly believed that a workforce having proper skills to combine the two worlds of power-train maintenance and refueling will play a key role in the next energy transition.

Keeping in mind all the reasons mentioned above, the overall goal of UpHyMob project can be grouped into four general objectives:

1. Define EU-wide occupational requirements for H_2 mobility technicians that reflect the needs in the H_2 mobility sector.
2. Design and deliver a joint curriculum & educational resource on H_2 mobility technicians' skills, to be embedded into formal & non-formal training provision.
3. Introduce and pilot test contemporary, flexible training delivery methods and open-access pedagogical resources, to support self-paced H_2 mobility skills acquisition.
4. Pave the way for the recognition, validation, integration of new skills requirements & qualification for H_2 mobility technicians into relevant schemes.

To accomplish the afore-explained objectives of the project, several actions need to be implemented:

1. Mapping of the technical skills needed for hydrogen mobility technicians and the training courses need to cover the technician skills
2. Development of a course curriculum on H_2 mobility skills and creation of corresponding training and assessment materials to be offered as Open Educational Resources.

3. Development of a Massive Open Online Course on H_2 mobility sector skills, promoting the uptake of innovative and flexible learning.
4. Development of a trainer's handbook for the integration of the UpHyMob learning outcomes in H_2 mobility in-house training.
5. Involvement of key sectoral stakeholders for the integration of the project results in VET and in-house training offerings & workplace practices, through the development of a Statement of Support.
6. Validation of skill requirements by sectoral and industry representatives (e.g. industry endorsement).
7. Dissemination of the project results through multiplier events, inviting target groups to uptake the UpHyMob results and to act as further multipliers.

2 THE MAIN EXPECTED RESULTS OF THE PROJECT

The Project Results expected to be achieved along with the UpHyMob activities can be grouped in 4 categories:

- R1: The first result develops the learning outcomes for H_2 power-train and Hydrogen Refuelling Station (HRS) maintenance and installation, namely what learners should know, understand and be able to do upon the successful completion of the UpHyMob curriculum. The design and development of these outcomes will be based on research on current training needs of (H_2) vehicle mechanics and skills shortages in the market, as the industry booms in the entire EU. These learning outcomes will address mainly practical but also theoretical needs, in order to ensure the proper and safe handling of the parts of H_2 powertrains and HRS. Furthermore, they will be designed in such a way so as to facilitate their integration to existing VET offerings for the H_2 mobility sector. An analysis of labour market needs (R1-T2) and relevant academic / vocational training offerings (R1-T3) will provide an informed basis for the development of the UpHyMob learning outcomes, which will set the ground for the curriculum design (R2).
- R2: This result will develop the modular curriculum structure of the UpHyMob project, which will be used by VET providers and in-house training centres in the H_2 mobility industry. The course will consist of 5-6 learning units; each unit will include a unique set of learning outcomes, defined in terms of theoretical knowledge, practical skills and competences, which can be assessed and validated in a consistent and coherent approach. Additionally, this result will include the development of a trainer and mentor handbook, with educational instructions, learning and assessment materials and practical examples designed to support the delivery of the UpHyMob curriculum. All materials will be based on the UpHyMob learning outcomes (R1) and learning units and will be offered as Open Educational Resources (OERs) for unrestricted third-party use. The main purpose is to enable (H_2) vehicle mechanics to acquire theoretical knowledge and practical skills through a combination of pedagogical resources that will help them be employed (or re-employed) in the field of the H_2 mobility sector. The partnership will also deliver guidelines to VET providers on how to integrate the learning units into existing training programmes and course offerings for the Renewable Energy Sector.

- R3: This result comprises the Massive Open Online Course (MOOC) infrastructures that will include:
    a. The UpHyMob learning units and contextualised training and assessment materials produced in R2 in online form (lecture notes/textual documents, presentations, multimedia files, online interactive tools). The whole content will be available in English, French, Portuguese, Spanish and Greek.
    b. Additional pedagogical resources such as video units and work assignments that will be developed to be embedded into the online course, in order to increase learners' engagement and course interactivity.

  The UpHyMob MOOC infrastructures will contain video units, supporting material (slides, hand-outs, self-tests), a discussion forum for interaction between participants (also between participants and facilitators) as well as periodic assignments. Furthermore, the partnership aims to run a 3 weeks pilot online course (R3-T3) to test the MOOC's functionality and identify weaknesses, areas of strengths and opportunities for improvement. The pilot will enable the partnership to evaluate and finetune the curriculum on the basis of participants' comments as drawn from actual usage and interaction with learning materials.
- R4: This output comprises the formation of a framework, to:
    a. promote the social recognition of learning outcomes – the acknowledgement of value of knowledge, skills and/or competences by industrial and social stakeholders (CEDEFOP, 2008), such as H_2 vehicle manufacturers, FC producers, the FCH JU, Hydrogen Europe, the ERMA Fuel Cells Task Force
    b. mainstream project materials as best practices for VET provision in the H_2 mobility sector
    c. lay the ground for the establishment of an EU-wide vocational (professional) qualification for technicians in the H_2 mobility sector
    d. promote the integration of relevant skills requirements into existing (sectoral) competence frameworks and EU classification systems
    e. support decision making on VET and skill development policies.

3 R1: H_2 MOBILITY SKILLS MAPPING AND UPHYMOB LEARNING OUTCOMES

The outcomes obtained from R1 are based on field and desk research on the technical skills and theoretical knowledge required by the H_2 mobility sector. Relevant information was gathered through online surveys, interviews with industry experts and relevant stakeholders (hydrogen mobility industries, companies and associations, field experts, VET providers, researchers), and literature review. Desk research on existing fuel-cell mechanics education/training programmes provide a basis for the structure of the curriculum and reveal trends in skill needs for the H_2 mobility sector. R1 relies on CEDEFOP guidelines and ECVET principles to develop the learning outcomes, providing also clear references to the appropriate EQF level(s), so as to secure the formation of common training standards/requirements and facilitate recognition of skills.

The tasks comprised into R1 are divided as following:

- R1-T1. Research methodology to gather skills intelligence in the H_2 mobility sector
- R1-T2. Evidence collection on skills requirements to define the current skills demand
- R1-T3. Review of existing training provision to define the current skills supply
- R1-T4. Definition of UpHyMob Learning outcomes based on skills needs analysis

To guarantee the results quality of "UpHyMob project", it is crucial to search for available trainings to understand their weaknesses, shortcomings and improvement needs. In addition, it is necessary to have evidence on training needs that justifies the need for new formative programs. Such evidence can be provided by different sources, like governmental employment agencies, future employment outlook studies or national hydrogen roadmaps. However, one of the most important sources is the market itself, composed by experts, professionals, and employers.

The present document contains the analysis of evidence gathered in the previous tasks, drafting the learning outcomes report and providing a solid and reliable basis for the development of a training content focused on solving the shortcomings of the current offer. This document would also present to the learning outcomes which, at a later stage, will conclude to UPHYMOB curriculum.

The following three sections are an analysis of three of the tasks included in R1. Firstly, the bibliographical evidence on the need for training is evaluated in order to identify the most urgent needs. Afterwards, the results of a survey of experts are analysed. This survey will be served as a key tool to fully understand the specific needs in the mobility field. Lastly, the current offer on hydrogen in mobility training is studied to evaluate the training opportunities already available in the market.

The report is then concluded with an analysis of the EFQ levels required in the identified skill needs and the description of the next steps for learning materials development, establishing the baseline for the development of the UPHYMOB curriculum.

3.1 SKILL NEEDS EVIDENCE

The UpHyMob project aims to upcycle hydrogen and mobility skills in the labour market. To this end, it is pivotal to collect some evidence about what is actually needed. For this reason, UpHyMob partners have gathered evidence from relevant studies (scientific articles, reports, etc), news, workplans and other sources that show the aspects that have to be developed in order to achieve European, national and regional targets. The total number of evidence collected within all UpHyMob partners is 31. The KPIs initially targeted as well as those finally achieved for the skills needs are reported in detail in Figure 14,in Annex.

The most important findings obtained from such analysis can be drawn as following:

- Hydrogen is being included in the most part of sustainable development, business and energy goals. Therefore, in order to achieve all these goals, a labour supply that includes technicians trained to work with hydrogen will be necessary.
- Since hydrogen market is still not totally stablished and it needs more research and development (R&D), a required technical and high-level STEM education is clearly. However, it will soon be necessary to have technicians capable of installing the equipment developed in the market, operating the installations, performing maintenance tasks, solving problems and all this under the appropriate safety conditions and procedures.
- Market currently accounts with a large workforce comprehending very expert technicians in their fields who might risk their own professional stability during the transition to a more sustainable economy. Even though the current technicians have lots of experience in fields quite close to the H_2-related ones (e.g., natural gas expertise), they cannot apply to hydrogen jobs, given that the hydrogen industry requires a higher level of knowledge and expertise.
- Reports show a clear need of technicians in every part of the value chain, including mobility. As it was mentioned before, the upskilling process may benefit of the similarities of many aspects to deal with between the upcoming hydrogen workforce and the existing one.

3.2 SURVEYS

Hydrogen technologies and their implementation are still in its infancy. However, an increasing public and industry interest has been being visible during the last years. In the short-term strategy of many companies to the implementation of hydrogen in their value chain is already foreseen. Nevertheless, to accomplish this goal, properly skilled professionals are required. In light of this, asking experts can provide a more specific view of what they need in their businesses.

Within the UpHyMob framework, a survey in different EU Member States (i.e., Spain, Portugal, Greece and Belgium) has been carried out, with the objective to outline a more defined overview of the upskill needs at academic/industrial level. The total number of answers is 81, less than the expected target (100). The reason behind this can be found in the low engagement and the low number of experts in hydrogen mobility. The corresponding KPIs for this section are given in detail in Figure 15 in Annex.

From the mentioned survey, four main groups appeared evident as we can see in Figure 1. Academic/Researchers and field experts/consultant in H_2 and/or mobility field, employers/company owner, and managers, representing more than 82% of the total interviewees.

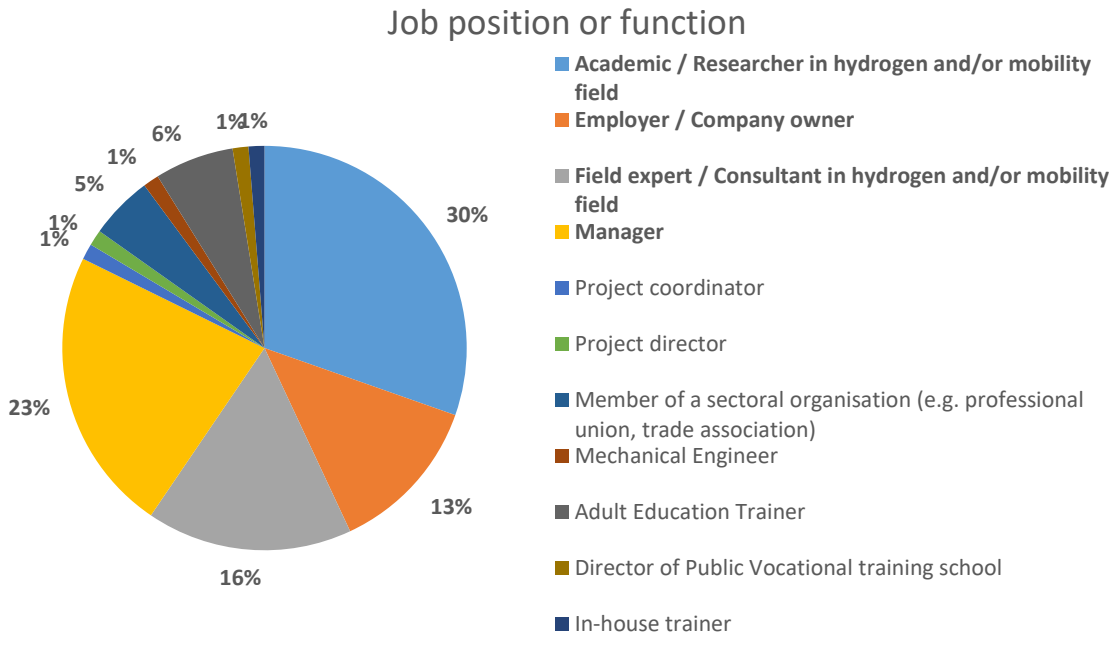

Figure 1. Interviewees job position or function.

Figure 2 shows the type of organisation which each interviewee belongs to. The most part comes from research centres (26%), energy related providers (25%) and high education providers (14%).

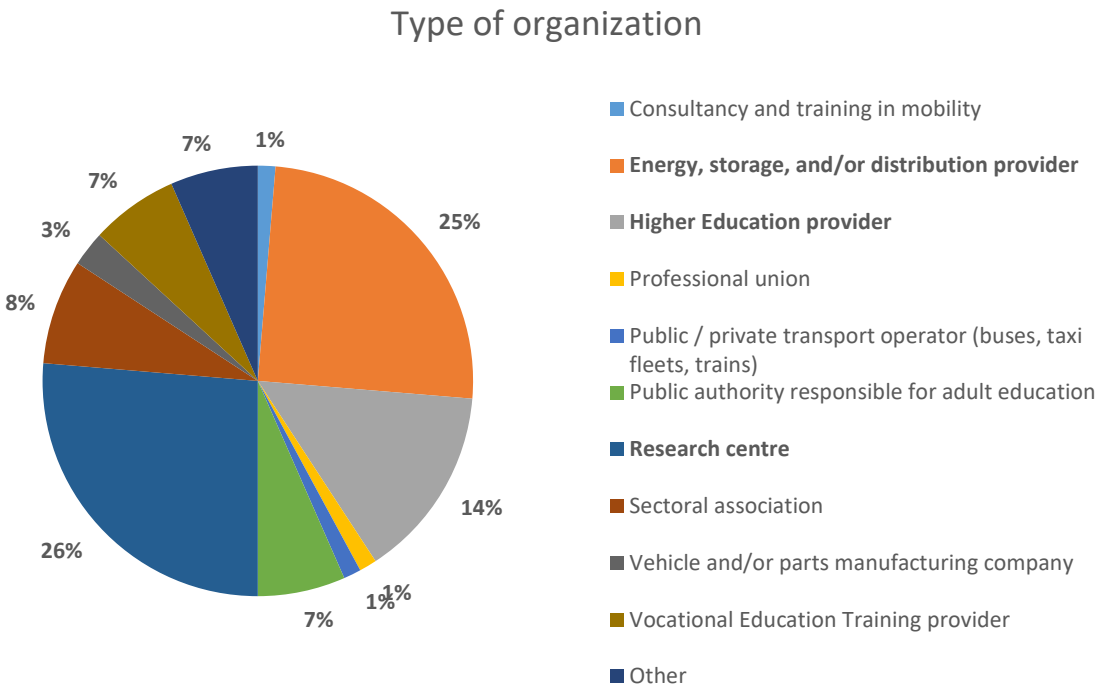

Figure 2. Interviewee's type of organisation.

In terms of employment (Figure 3), results show the current low maturity of the hydrogen market. Indeed, almost 50% of the answers indicated that surveyed companies have no employees properly skilled to work with hydrogen.

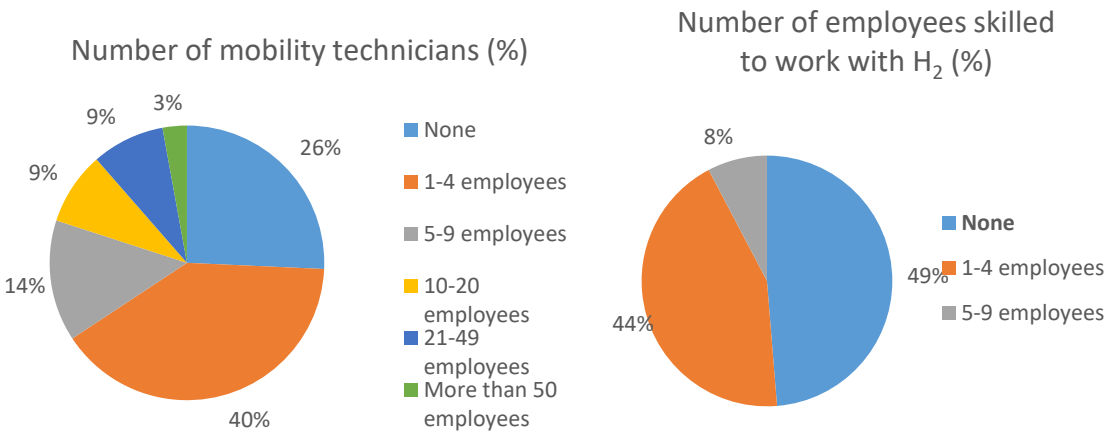

Figure 3. Number of employees.

On the other hand, it is possible to observe that almost 50% of the sample consider they are very familiar with the use of hydrogen as a fuel and almost 60% have already worked on hydrogen applications or related services in the mobility sector, as shown in Figure 4.

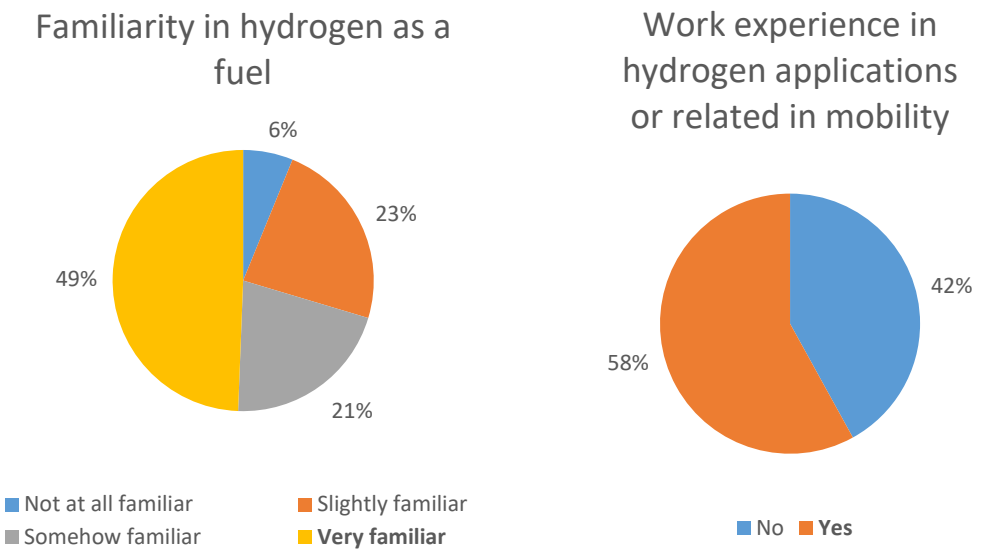

Figure 4. Familiarity in hydrogen as a fuel and work experience in hydrogen applications or related in mobility.

Figure 5 reflects that the hydrogen market is still in its infancy. Unexpectedly, there exists a non-negligible percentage of professionals (21%) having more than 6 years of experience (21%), probably related to the high number of H_2-based research projects present during the last years.

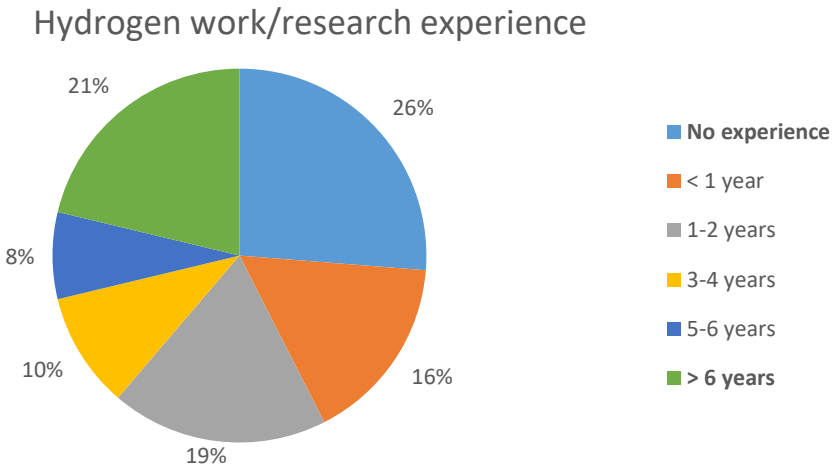

Figure 5. Hydrogen work or research experience.

Further survey results were provided by a high level, experienced and relevant participants successfully targeted by UpHyMob partners.

The main part of the survey consisted in addressing specific skills and evaluate their importance, availability in the labour market and coverage by training offer. Participants had to select among different options, in detail very high (5), high (4), moderate (3), low (2) and none (1) for those three categories. Results are shown in Figure 6. The skills topics that were scored as the most important are:

- "Hydrogen equipment, inspection operation and maintenance",
- "Safety protocols and provisions for working with or around stored hydrogen fuel",
- "Electrical or mechanical documents or blueprint/plans regarding specifics for assembly products".

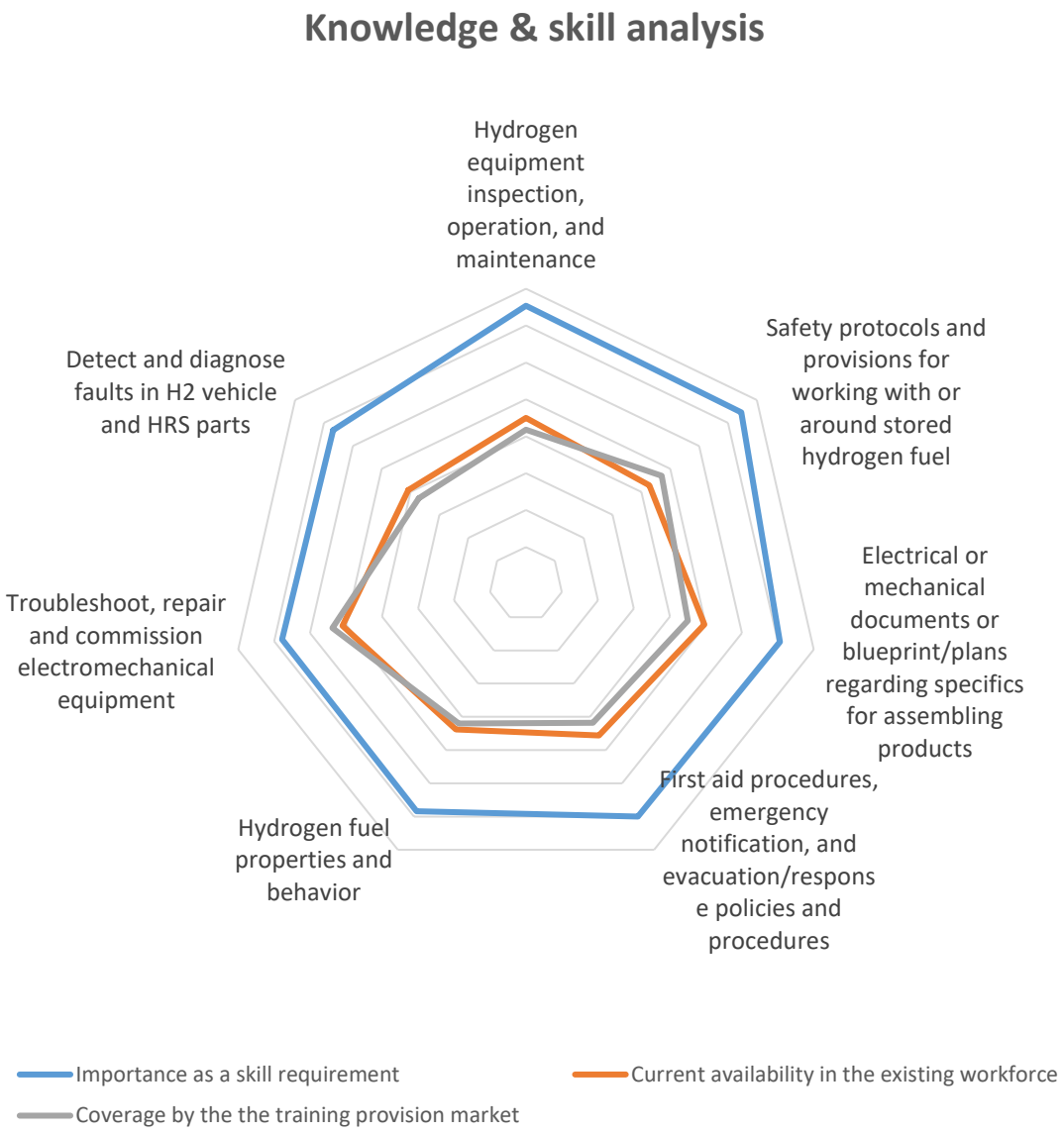

Figure 6. Skills listed by their importance, ordered clockwise from the highest to the lowest

Figure 6 summarizes in a spider-graph the results gathered during the surveys related to the required, relevant skills. For each of them, three different aspects can be analyzed: importance as a skill requirement (in blue), coverage by the training provision market (in grey) and current availability in the existing workforce (in orange). It is important to keep in mind that the longest the distance between the importance as skill requirement and the coverage by the training provision market, the greatest the need to develop the corresponding subject of skills. In this sense, it might be worth to use the distance between the three lines to study their correlation and to detect the need of development of new trainings and the urgency of provision them to the labour market.

Looking at the Figure 6 it can be noticed the existence of big gaps between the **importance** as a skill requirement (in blue) and the **coverage by the training provision market** (in grey). By evaluating them, it is possible to observe four main skills to be developed in training programs:

- Hydrogen equipment, inspection operation and maintenance.
- Detect and diagnose faults in H_2 vehicles and HRS parts.
- First aid, emergency and response procedures.
- Safety protocols and provisions related to hydrogen storage.

However, it can also be noticed there is a remarkable difference between **importance** as a skill requirement (in blue) and the **current availability in the existing workforce** (in orange) too. In this case, some skills are repeated from the two previous analysis but the priority order slightly varied:

- Safety protocols and provisions related to hydrogen storage.
- Hydrogen equipment, inspection operation and maintenance.
- Detect and diagnose faults in H_2 vehicles and HRS parts.
- Hydrogen fuel properties and behaviour.

It is key to notice two other aspects in this analysis:

1. There is a great difference between the points given when evaluating the importance of the named skills (outer blue line) and the other two subjects (inner grey and orange lines). This aspect indicates by itself there is a big gap to be filled. The average score for *importance as a skill* was 4.36/5 points while *market coverage* was only 2.80/5 and the *current availability on the workforce* 2.89/5 points. These results show the actual need to develop more training programs and to upskill the workforce.
2. All skills have been identified as very important with an average score of 4.36/5 points and they share very similar values (Figure 7).

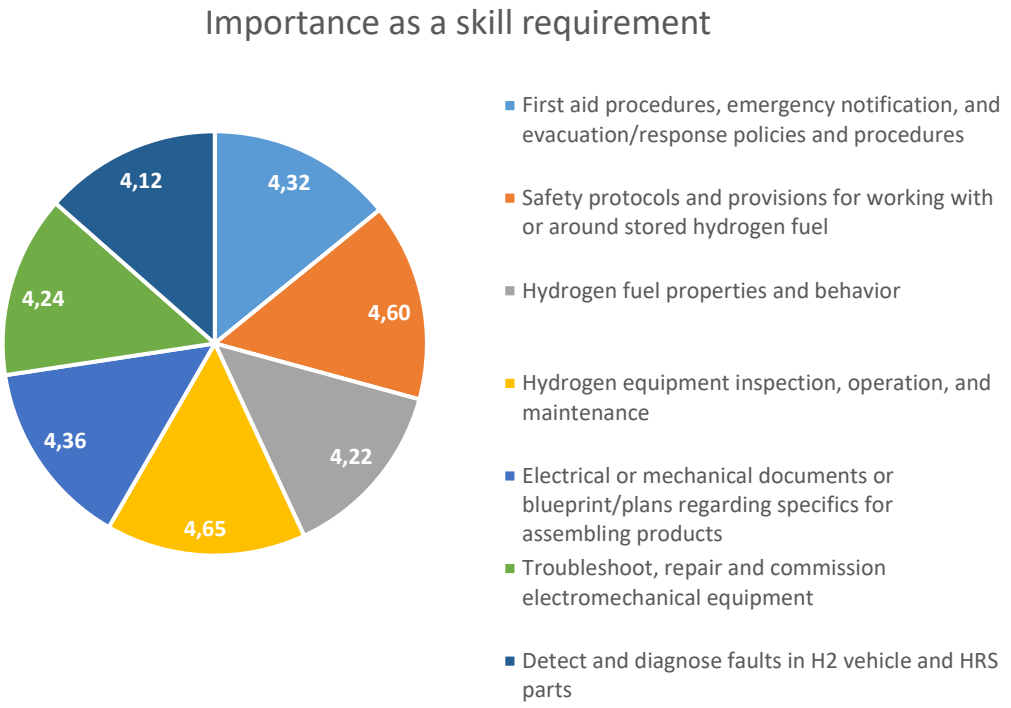

Figure 7. Skill requirement importance punctuation share from 1 to 5 points.

Concerning the recruiting phase, 66% of the interviewees experienced some difficulties in looking for appropriate staff to carry out hydrogen mobility-related tasks. Figure 8 shows the results.

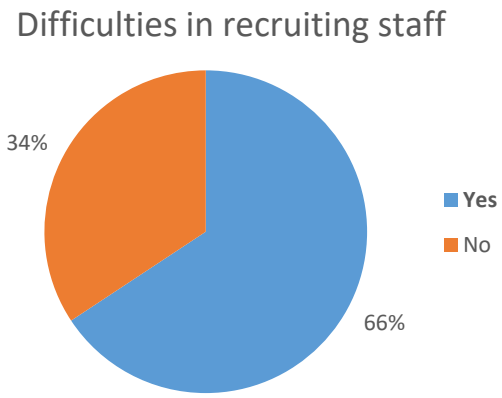

Figure 8. Difficulties in recruiting staff and staff skill needs reviewing regularity.

On the other hand, the most important type of difficulties detected by the interviewees during the recruiting phase (Figure 9) are the following:

- Low number of applicants with the required hydrogen mobility technical skills (23%)
- Lack of work experience (19%)
- Lack of skills relevant to the hydrogen fuel cell application (19%)
- Low number of applicants in general (16%)

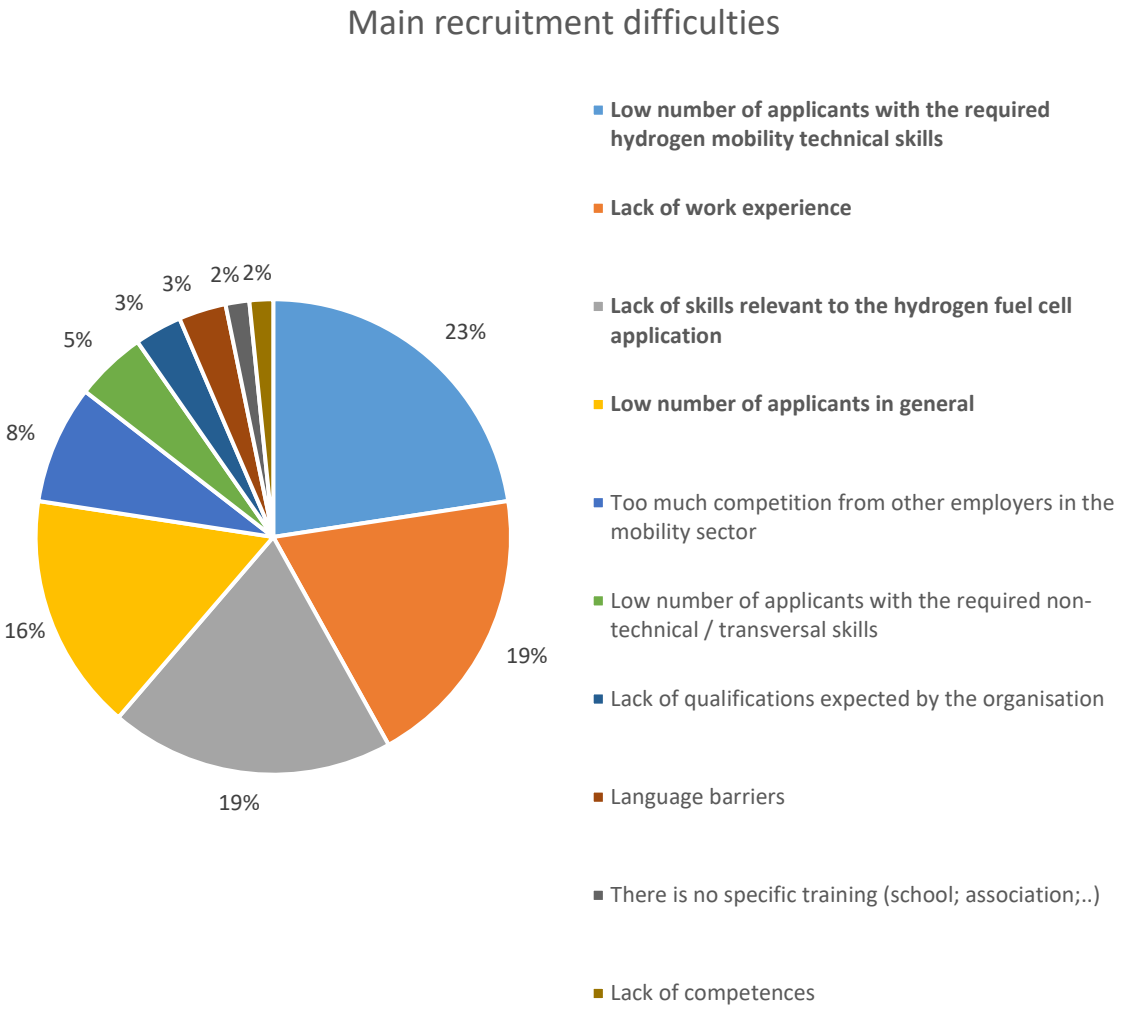

Figure 9. Main recruitment difficulties found when recruiting staff to carry hydrogen related tasks in the mobility field.

From these results, the need for hydrogen training programmes was remarked, especially in the mid-long term. On the other side, it is also important to note that the applicants seem to already have the correct non-technical skills as language, qualification and competences.

The last part of the survey was focused on training and workforce development. The first question was related to the interviewees periodical monitoring of their staff's skill needs (.

Figure 10 shows that approximately 65% have the opinion that to monitor the staff skills needs once a year, while a 17% every six months. The percentage left of interviewees (17%) affirmed to do not carry out any skills need review, in absence of an existing staff.

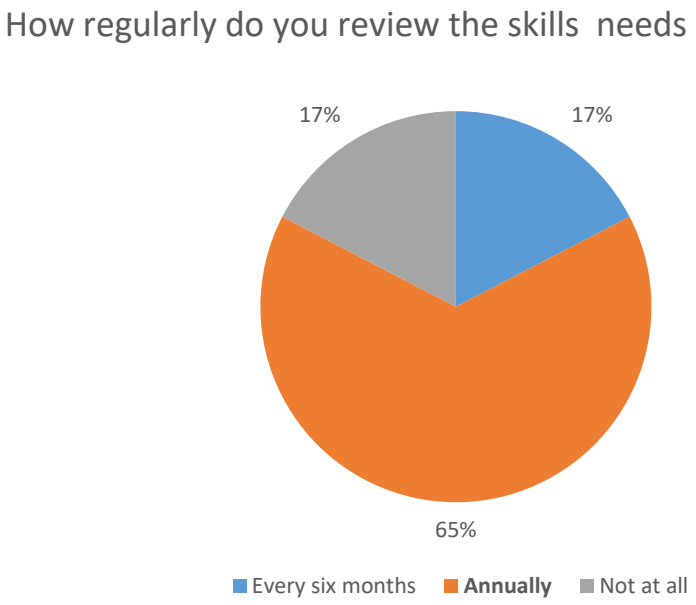

Figure 10. Regularity in staff skill needs review

The other aspect covers by the surveys is the distribution concerning the main barriers to providing hydrogen training. According with the answers show in Figure 11, the three main aspects indicated by the participants as obstacles were the lack of training offerings (26%), price (23%) and lack of time to dedicate to the completion of trainings (21%). The lack of flexible and convenient training offerings also achieved a non-negligible percentage (11%), which confirmed to be another important aspect to be considered when designing the programmes. Finally, it is relevant to notice that only 2% of answers did not find any difficulties in training their workforce.

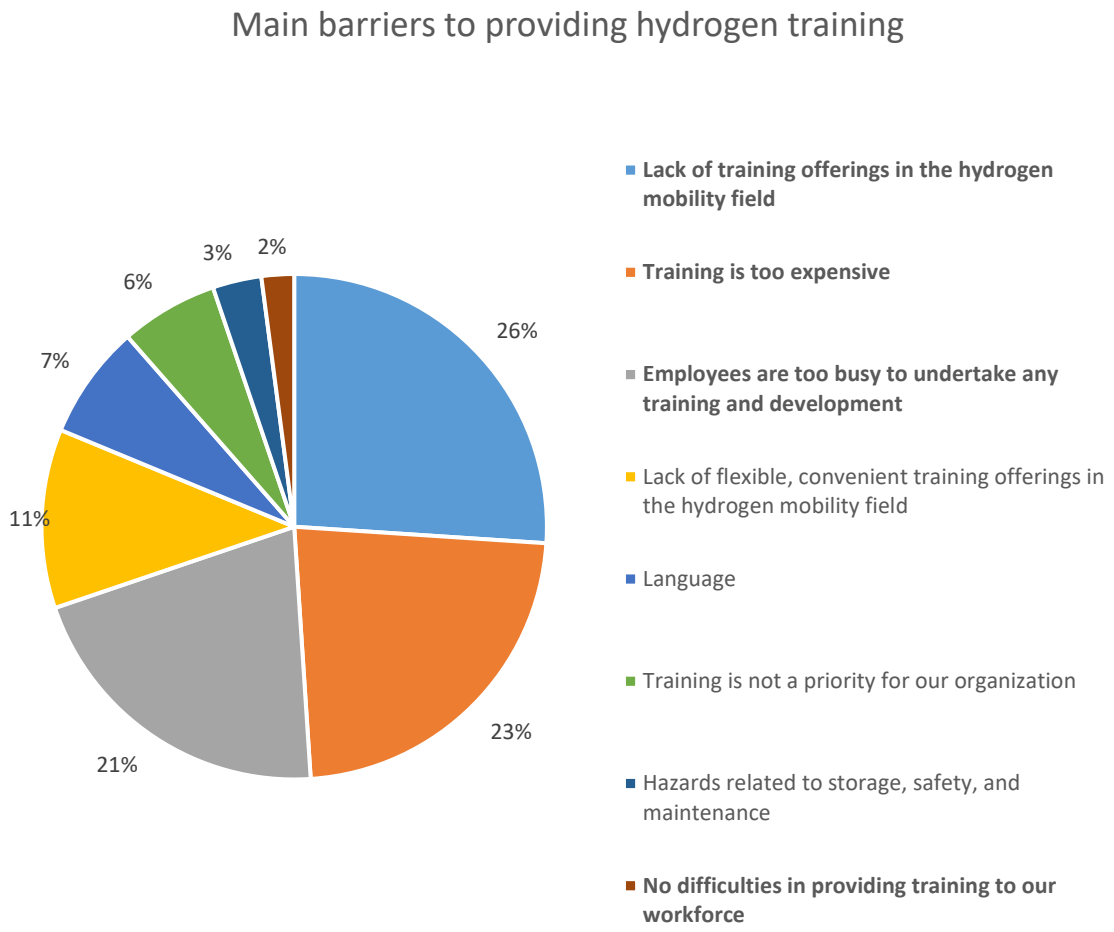

Figure 11. Main barriers to providing hydrogen training

3.3 AVAILABLE TRAININGS

UpHyMob partners carried out desk research on identifying in partners' countries formal and no formal trainings related to the hydrogen technologies and/or mobility in order to assess the existing market offer. The main goal is to understand the most common topics and target audiences, to identify the missing points to fully cover the present and future skill needs. The first aspect to mention is the high difficulty experienced by UpHyMob partners in compiling a high number of offers in the current market. There is a significant lack of training offers in the hydrogen field, mainly in the mobility applications, which are the main topic addressed by the market. The final number of training offers found among all UpHyMob partners is only 25, even though the target was 30. The KPIs related to the current trainings available in the market are shown in Figure 16 in Annex.

Results show a clear majority of **private** entities providing these trainings (>70%) and it is also difficult to find formal content (<33%) and **certifications** due to the lack of standardization. On the other hand, the most popular **types of training** are online courses, high education, and seminars correspond to a total of 75%. More than 80% are based on **distance learning** or include some blending with classroom training.

Finally, courses durations vary between a single day and more than 1000 hours. However, the average range is between 15 to 150 hours.

4 LEARNING OUTCOMES DETAILS AND EQF LEVELS REFERENCES

The European Qualifications Framework for Lifelong Learning (namely, EQF levels) is a common reference framework created by the European Union that links countries qualifications systems, allowing correct interpretation of qualifications in different countries. Taking into account, the results described in this report and the corresponding knowledge degree for each EQF level, it is possible to conclude that the identified target EQF levels are #3, #4 and #5. The mentioned levels are described in detail in Figure 12.

LEVEL	KNOWLEDGE	SKILLS	RESPONSABLITY AND AUTONOMY
1	Basic general knowledge	Basic skills required to carry out simple tasks	Work or study under direct supervision in a structured context
2	**Basic factual knowledge of a field of work or study**	Basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools	Work or study under supervision with some autonomy
3	Knowledge of **facts, principles, processes and general concepts**, in a field of work or study	A range of cognitive and practical skills required to **accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information**	Take responsibility for completion of tasks in work or study; **adapt own behaviour to circumstances in solving problems**
4	**Factual and theoretical knowledge** in broad contexts within a field of work or study	A range of **cognitive and practical skills required to generate solutions to specific problems in a field of work or study**	Exercise self-management within the guidelines of work or study contexts that **are usually predictable, but are subject to change**; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
5	**Comprehensive, specialised, factual and theoretical knowledge** within a field of work or study and an awareness of the boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others

6	**Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles**	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups
7	Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research Critical awareness of knowledge issues in a field and at the interface between different fields	Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams
8	**Knowledge at the most advanced frontier of a field of work or study and at the interface between fields**	The most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research

Figure 12. European Qualifications Framework Levels and their requirements. Source: Europa.eu

As previously reported in the present document, the main subject of skills to deliver are:

a) Hydrogen equipment, inspection operation and maintenance.
b) Safety protocols and provisions related to hydrogen storage.
c) First aid, emergency and response procedures.
d) Detect and diagnose faults in H_2 vehicles and HRS parts.

These four skills can be identified within with EQF levels. However, it is key to understand the tasks related to those skills before deciding the EQF level associated.

Firstly, there is no need for special training for those that will be working in the equipment factories since manufacturing process are very common. On the other hand, dimensioning installations requires very specific and high-level training, which are related to higher EQF levels out of this report's scope.

a) Hydrogen equipment, inspection operation and maintenance

Equipment installation is considered to be the greatest need in the short, mid and long term. Installation requires knowledge of joints, high pressure systems, controls, electric circuits, etc. It also implies to understand risks, to follow procedures and a correct handling. This part of the equipment-related skill can be developed with EQFL 3 training.

Most of the systems will rely on automatisms and informatic controls for their maintenance. Therefore, it is necessary to account with a professional figure who understands the procedures, possessing an appropriate knowledge of the installation, its parts and characteristics to solve problems in an effective and safe way when it is required. In conclusion, system dimensioning, risk and people management are key indicators to keep in mind when it comes the moment to define the next H_2 workforce. Therefore, at least a EQF level of #4-5 is required.

b) Safety protocols and provisions related to hydrogen storage and c) First aid, emergency and response procedures

When working with hydrogen, as with other inflammable gases, safety is a priority. Understanding the correct way to operate and good practices is fundamental. That means that safety must be learned by all levels, regardless the EQF level. All employees working in the surrounding area should be trained in basic safety procedures, first aid and emergency response. Safety experts will be required in dimensioning installation and on audits. Those profiles could be identified as EQF level 4 to 5 due to their responsibility and key role in supervising others.

d) Detection and diagnosis faults in H_2 vehicles and HRS parts.

Hydrogen Refueling Stations (HRS) are, in brief, H_2 installations with high pressure gas storage. In the short term they are not expected to produce hydrogen on-site; they rather will account on a distributed system, based on H_2 transport by trailers for the supply phase. In light of this, HRS-related technicians must take charge of several tasks:

- HRS installation
- HRS maintenance and safety operation
- Unload of hydrogen transport trucks (if required)
- Refueling vehicles

Hydrogen vehicles, on the other hand, will have to work in troubleshooting, diagnose and repairing vehicles faults. Vehicles can be more complex since they have several systems

integrated: high pressurised vessels, hydrogen tubing, fuel cell/s, auxiliary systems, other common systems related to the electric motor and the usual mechanic systems of traditional cars. It is important to mention that currently there already exist detailed vehicle training offers; EQF #4 is actually required to upskill workshop employees and roadside assistants. In Figure 13 sums up all the EQF levels considered in the skills analysis presented in this report.

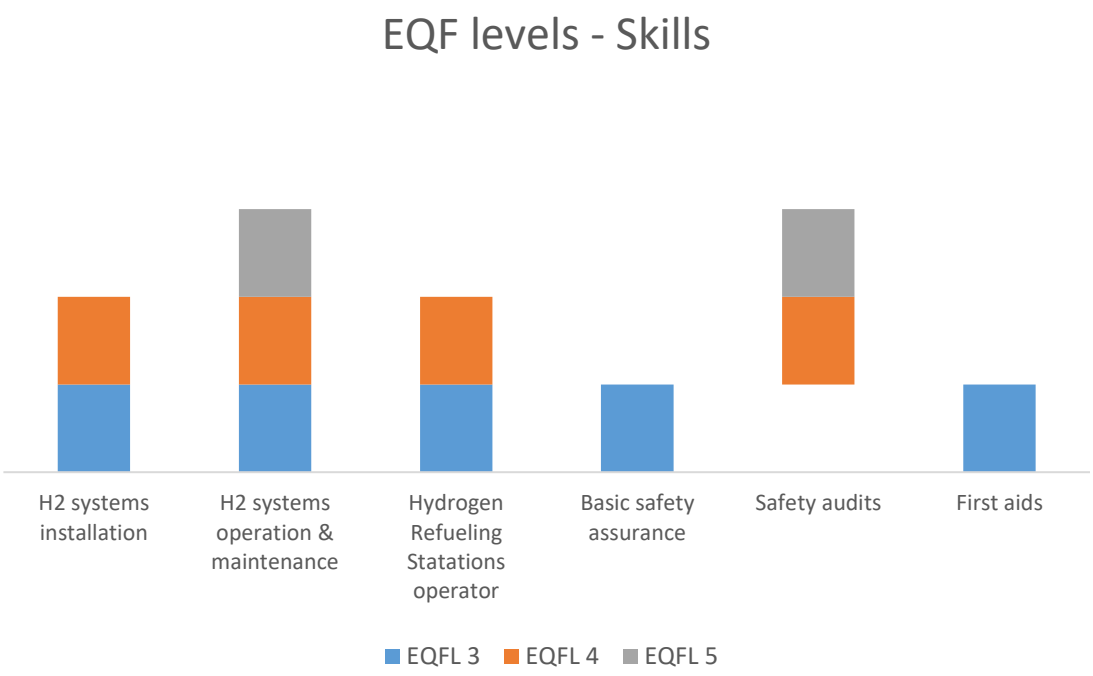

Figure 13. EQF levels for each detected skill need

5 NEXT STEPS FOR LEARNING MATERIALS DEVELOPMENT

The main barriers when providing training were clearly identified, showed in Figure 11 as well as in Figure 9 the main difficulties when recruiting staff were highlighted. Actions that can be implemented to address these two topics are:

- Developing a flexible, online course mentored by professionals.
- Provide solid theory materials and to complement them with seminars and/or videos to allow students to see and hear instead of just read.
- To collect contacts in companies as stakeholders to connect students with the industry To develop a proper network among companies in order to allow students to have easy access to their public resources and job offers.
- Offering optional curricular internships, individually or remunerated by the companies, to the students by means of the before-mentioned networking activities.

In order to cover the previously selected subjects of relevant skills, the didactic units should be structured around the following three main areas:

a) Hydrogen equipment inspection, operation and maintenance
b) Safety protocols and emergency response procedures.
c) Detect and diagnose faults in vehicles and Hydrogen Refueling Stations parts.

The following structure would address all topics:

1. Hydrogen basic properties and behaviour
2. Safety management and procedures
3. Basic H_2 storage concepts as a high pressure gas
4. Applications
    a. Fuel cells. Basic principles, operation, parts and auxiliary systems
    b. H_2 combustion. Internal combustion engines, boilers and turbines.
5. HRS parts and operations
6. Protocols and routines, control and problem solving.

6 CONCLUSIONS

An analysis of desk research and survey results has been conducted in order to provide the necessary information for developing a successful training program.

Research studies show there is a clear need for hydrogen skills in the whole value chain, especially in technicians and equipment operators. The current training offer available in the market is not meeting the needs of the industry, and the current workforce is still not ready for hydrogen-based technologies.

A survey of industry experts has been conducted to better understand this problem. There are some key skills to be developed which are primarily related to equipment operation, maintenance, fault diagnose as well as safety and emergency response. On the other hand, general and basic value-chain concepts are already covered by the current offer.

In addition, some problems that companies have when training their employees were identified. Over 80% of those barriers can be solved by increasing the number of mobility trainings, making them less expensive or even free, and delivering them in a flexible way that does not require excessive amounts of time.

Referring to the research questions reported in R1-T1 deliverable, the mentioned questions can be addressed as following:

The EQF level should also be defined when developing training based on the above points. The most appropriate levels for the training to be carried out are 3, 4 and 5.

7 ANNEX

The next figures show Key Performance Indicators regarding sections 3.1, 3.2 and 3.3 with target values and the finally achieved.

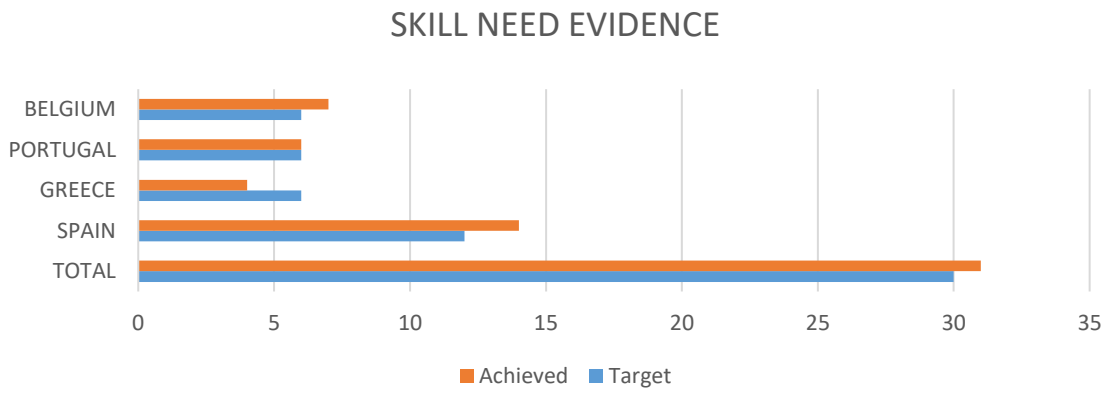

Figure 14. Desk research KPI results about skill need evidence

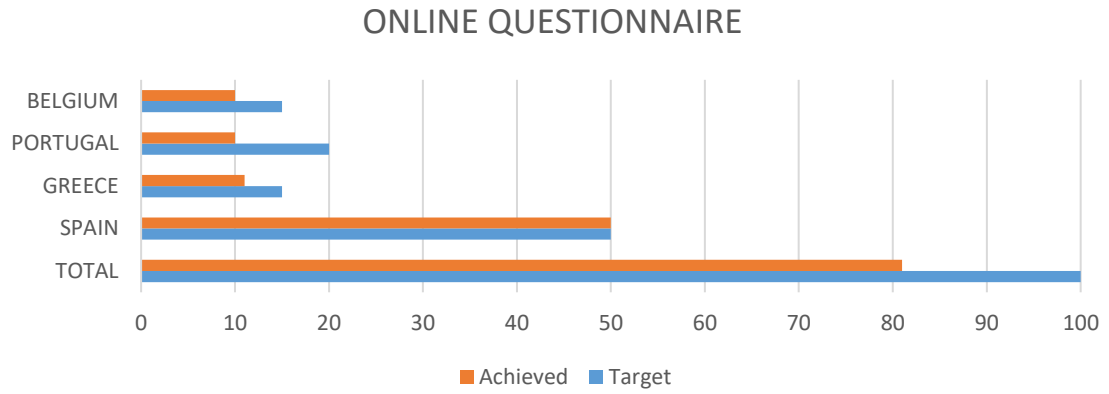

Figure 15. Online survey KPI results

Figure 16. Desk research KPI results about training offers