GREEN SKILLS FOR HYDROGEN

Green Skills for Hydrogen

Identify Occupational Profiles and Urgent Skills Needs

Deliverable D2.1 I 31 DECEMBER 2022

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About the European Hydrogen Skills Alliance

Hydrogen is a key pillar of the EU's strategy to achieve its 2050 decarbonisation goals. The rapid development of the European Hydrogen Value Chain over the coming years is expected to generate approximately 1 million highly skilled jobs by 2030, and up to 5.4 million by 2050[1]. This growth presents a significant economic and environmental opportunity for Europe, but it also creates considerable labour market challenges.

The European Hydrogen Skills Alliance "GreenSkills4H2" is a four-year project, started in July 2022, bringing together partners from 15 European countries and funded under the EU's Erasmus+ programme. The primary objective is to design and implement a highly innovative, effective, and sustainable Hydrogen Skills Strategy for Europe that will ensure the skills needs of the rapidly expanding and evolving Hydrogen Value Chain can be met in the short, medium, and long term. It will also generate a blueprint to address the skills need of workers in Declining Sectors and Transition Regions to provide them with upskilling and reskilling opportunities within the Hydrogen sector.

GreenSkills4H2 will establish a long-term partnership between Industry and Education. It will design an innovative and sustainable Hydrogen Skills Strategy. It will develop, test and roll-out of VET curricula and training programmes in line with latest market needs and consistently linked with EU instruments and tools. It will foster continuous skills and career development that empower technical professionalism in both green and digital competences. Finally, it will disseminate and rollout the VET training to maximise European impact.

The Green Skills for Hydrogen Alliance

GreenSkills4H2 is an Alliance of Hydrogen sector's actors led by Karlsruher Institut für Technologie (KIT), Hydrogen Europe and Hydrogen Europe Research, bringing together key Industry and Education stakeholders from across the sector. Its composition is presented in the following table.

Partners	Acronym
Adecco Formazione / Mylia	**Mylia**
Advent Technologies	**Advent**
Austrian Institute of Technology	**AIT**
Cluster of Bioeconomy and Environment of Western Macedonia	**CluBE**
CP Europe	**CP**
Danmarks Tekniske Universitet	**DTU**
Foundation for the Development of New Hydrogen Technologies in Aragon	**FHA**
Howden	**Howden**
Hydrogen Europe	**HE**
Hydrogen Europe Research	**HER**
Enerdata	**Enerdata**

[1] Source: Hydrogen Roadmap Europe, FCH-JU, 2019

Partners	Acronym
Institute of Electrochemistry and Energy Systems	**IEES**
Karlsruher Institut für Technologie	**KIT**
National Research and Development Institute for Cryogenics and Isotopic Technologies ICSI Rm. Valcea	**ICSI**
National University of Ireland Galway	**NUIG**
NHL Stenden University of Applied Sciences	**Stenden**
Nuovo Pignone Tecnologie / Baker Hughes	**Baker Hughes**
Politecnico di Torino	**Polito**
Region Auvergne Rhone Alpes	**AURA**
Regional Pomeranian Chamber of Commerce	**RIGP**
ROC Drenthe College	**Drenthe**
Skillnet Ireland	**Skillnet**
SNAM	**SNAM**
Tallinn University of Technology / EMERA	**TalTech**
Tartu Vocational Education Centre	**Tartu VEC**
University of Perugia	**Uni Perugia**

Associated partners	
Association Française pour l'Hydrogène et les Piles à Combustible	**France Hydrogène**
Epia Solarpower Europe	**EPIA**
Industriall	**Industriall**
New Nel Hydrogen	**Nel**
Tartu Regional Energy Agency	**TREA**
Trakiyski Universitet / Institute for Sustainable Transition and Development	**ISTD**
WindEurope	**WindEurope**
Affiliated partner	
MODIS Consulting	**MODIS**
Subcontractors	
University Politehnica of Bucharest	**UPB**
Schuman Associates	**SA**

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Contents

1. Introduction

Work Package #2 of GreenSkills4H2 aims at defining the Occupational Profiles and the Skills Needs for hydrogen at the European scale and develop a dedicated Skills Strategy. The deliverables aim at providing clarity and focus for people seeking new roles within this sector, allow hydrogen companies to meet very specific skills needs and provide trainers and educational institutions with clear targets.

Work Package 2 consists of 4 tasks which spread until middle of 2023. The primary objective of the first task, task 2.1, was to identify current and emerging Occupational Profiles and urgent Skills Needs that are necessary for the development of the hydrogen sector. This task aimed at gathering a first status on this topic within a few month in order to provide early feedbacks to the other work packages that proceed in parallel to Work Package 2. The following Task 2.2 will develop interviews over a much larger basis (aiming 100 interviews).

The focus is specifically on high demand roles and those requiring advanced technical and engineering skills for industry needs. To complete this task, a specific interview guide was designed to prepare interviews with various European stakeholders involved in the hydrogen sector: industrial companies, national hydrogen associations, hydrogen clusters and academics. This document is the synthesis of this first interview campaign, using the ESCO classification for Occupations, the common framework mapping jobs on the EU labour market.

2. Definitions

ESCO: is the multilingual classification of European Skills, Competences, and Occupations. The ESCO classification identifies and categorises skills, competences, and occupations relevant for the EU labour market, education and training.

Occupational profiles: classification of jobs within the EU labour market. In this framework, 3008 different « occupations » are listed. Each occupation is mapped to one ISCO-08 code. ISCO-08 can therefore be used as a hierarchical structure for the occupations pillar.

Skills: means the ability to apply knowledge and use know-how to complete tasks and solve problems.

Competence: means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development.

Qualifications: are the formal outcome of an assessment and validation process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards.

3. Results of the interview campaign of Task 2.1

During this task, a total of 20 interviews have been conducted. This interview campaign aimed at collecting inputs from Europeans players of the hydrogen sector, specifically on occupational profiles and skills needs. Table 1 and Table 2 list and summarize organisations that have been surveyed during this task.

Country	Industry	National hydrogen association or cluster	Educational institution	Number of interviews per country
Slovakia		Slovak National Hydrogen Association		1
Finland	Wärtsilä	Hydrogen Cluster Finland		2
Italy	SNAM, Baker Hughes, De Nora		Politecnico di Milano	4
Switzerland			Ecole Polytechnique Fédérale de Lausanne	1
Netherlands	Howden	WaterstofNet		2
Belgium		WaterstofNet		1
Luxembourg		WaterstofNet		1
Greece	Advent			1
Ireland	EIH2			1
Poland	Gas-Trading		Prosper Advertising & Publishing	2
Estonia	LTH Baas, Skycorp	Estonian Association of Hydrogen Technologies		3
Austria	Andritz			1
Romania		Hydrogen Romania Association		1
Czech Republic			UCT Prague	1

Table 1: Contributors to the interview campaign

WaterstofNet is a hydrogen cluster of industrials located in the Benelux region. Therefore, it appears three times in Table 1, covering Netherlands, Belgium and Luxembourg, even if a single interview has been done.

Country	Materials & Components	System (Fuel Cell, Electrolyzer)	Production	Storage	Transport	End-Use
Finland	Wärtsilä					
Italy	Baker Hughes, De Nora			Snam	Snam	
Netherlands	Howden					
Greece		Advent				
Ireland			EIH2			
Poland				Gas-Trading	Gas-Trading	
Estonia						LTH Baas, Skycorp
Austria		Andritz				

Table 2: Position on the hydrogen value-chain from industrials interviewed

In addition to their positions on the hydrogen value-chain listed in Table 2, here are the activities that are or will be impacted by hydrogen from industrials interviewed:

- **Wärtsilä** manufactures engines and turbines for marine applications
- **Baker Hughes** manufactures compressors and gas turbines operating with hydrogen gas
- **De Nora** supplies high-performing catalytic coatings and insoluble electrodes for electrochemical and industrial applications
- **Howden** manufactures compressors operating with hydrogen gas
- **Advent** manufactures fuel cell
- **Andritz** develops Proton Exchange Membrane (PEM) electrolyzers and Anion Exchange Membrane (AEM) electrolyzers
- **EIH2** develops projects and invests in hydrogen production projects mainly for industrial applications
- **Snam** is the main Italian operator for the transport and dispatching of natural gas
- **Gas-trading** is part of the Polish group PKN Orlen and supplies energy carrier transport solutions mainly for liquefied natural gas
- **LTH Baas** is a marine company which builds, repairs and retrofits ships
- **Skycorp** manufactures hydrogen drones

4. ESCO classification

The ESCO classification identifies and categorises skills, competences and occupations relevant to the EU labour market, education and training. Regarding occupations, it uses the International Standard Classification of Occupations (ISCO) in order to gather them into a tree structure. In ESCO, each occupation is associated to one ISCO-08 code, it divides occupational profiles into ten major groups:

- 0 – Armed forces occupations
- **1 – Managers**
- **2 – Professionals**
- **3 – Technicians and associate professionals**
- 4 – Clerical support workers
- 5 – Service and sales workers
- 6 – Skilled agricultural, forestry and fishery workers
- **7 – Craft and related trades workers**
- **8 – Plant and machine operators and assemblers**
- 9 – Elementary occupations

Major groups highlighted in a **green font** have been identified as containing occupational profiles relevant to the hydrogen sector. They have been selected according to inputs from industrials interviewed and ESCO task descriptions.

5. Current and emerging Occupational Profiles for the hydrogen sector

In the ESCO classification, the ten major groups are divided in sub-major, minor and unit groups. The following sections present occupational profiles that are relevant for the hydrogen sector from each major group. The tree structure is further branched to the third level of the hierarchy for each second level identified as relevant. All levels leading to occupational profiles identified as relevant for the development of the hydrogen sector are highlighted in a **green font**.

In addition to occupational profiles identified from the ESCO framework, inputs from interviewees regarding jobs needs for the hydrogen sector are detailed for each major group. They are presented as they were mentioned during the interview campaign and divided into three categories, based on the hydrogen knowledge required for the role: low, medium, high. Distinction between these three levels of knowledge is based on the classification of the EQF levels.

A low hydrogen knowledge requirement (EQF level 1 to 2) means that the importance of hydrogen itself within tasks performed for this role is not of primary importance. Basic general and factual knowledge on hydrogen is necessary but restricted to a certain context, in order to carry out tasks and to solve routine problems using simple rules and tools.

A medium hydrogen knowledge requirement (EQF level 4 to 5) means that hydrogen has a significant importance within tasks performed for this role. Factual and theoretical knowledge in broad contexts is necessary and specialisation on certain topics can be relevant. It should provide a holistic hydrogen background to generate solutions to specific problems and enable the person to exercise management and supervision in contexts where there is a level of unpredictability.

A high hydrogen knowledge requirement (EQF level 7 to 8) means that the importance of hydrogen itself within tasks performed for this role is of primary importance. Highly specialised knowledge, some of which is at the forefront in a certain field or at the interface between fields is necessary. It should provide specialised problem-solving skills to develop new knowledge and procedures and to integrate knowledge from different fields, for research & development or innovation purposes.

Each occupational profile identified from the interview campaign is classified in one of these three categories, recognizable by its colour from light to dark green colour:

- **Low hydrogen knowledge required**
- **Medium hydrogen knowledge required**
- **High hydrogen knowledge required**

5.1 ESCO Group 1 - Managers

From the ESCO classification, tasks usually performed by managers and relevant for the hydrogen sector include:

"Ensuring appropriate systems and procedures are developed and implemented to provide budgetary control; authorizing material, human and financial resources to implement policies and programmes; monitoring and evaluating performance of the organization or enterprise and of its staff; selecting or approving the selection of staff; ensuring compliance with health and safety requirements; planning and directing daily operations."

Managers group tree structure:

1 – Managers

- **11 - Chief executives, senior officials and legislators**
  - 111 - Legislators and senior officials
  - **112 - Managing directors and chief executives**
- **12 - Administrative and commercial managers**
  - **121 - Business services and administration managers**
  - **122 - Sales, marketing and development managers**
- **13 - Production and specialised services managers**
  - 131 - Production managers in agriculture, forestry and fisheries
  - **132 - Manufacturing, mining, construction, and distribution managers**
  - 133 - Information and communications technology service managers
  - 134 - Professional services managers
- 14 - Hydrogen, retail and other services managers

According to the interview campaign, few occupational profiles are concerned in this major group:

- **Hydrogen project manager**

5.2 ESCO Group 2 - Professionals

From the ESCO classification, tasks usually performed by professionals and relevant for the hydrogen sector include:

"Conducting analysis and research, and developing concepts, theories and operational methods; advising on or applying existing knowledge related to physical sciences, mathematics, engineering and technology; teaching the theory and practice of one or more disciplines at different educational levels; providing various business, legal and social services; preparing scientific papers and reports."

Professionals tree structure:

2 – Professionals

- **21 - Science and engineering professionals**
  - **211 - Physical and earth science professionals**
  - 212 - Mathematicians, actuaries and statisticians
  - 213 - Life science professionals
  - **214 - Engineering professionals (excluding electrotechnology)**
  - **215 - Electrotechnology engineers**
  - 216 - Architects, planners, surveyors and designer
- 22 - Health professionals
- 23 - Teaching professionals
- **24 - Business and administration professionals**
  - Finance professionals
  - **Administration professionals**
  - **Sales, marketing and public relations professionals**
- 25 - Information and communications technology professionals
- 26 - Legal, social and cultural professionals

According to the interview campaign, there is a high demand for engineers, Master and PhD holders in a multiple technical fields:

- **Mechanical engineer**

- **Power electronics engineer**
- **System production**
- **Design engineer / Project designer**
- **Sales engineer**
- **Administrative staff from public institutions: governments, regions, municipalities**

- **Electrical engineer**
- **Automation engineer**
- **Hydrogen production specialist**
- **Hydrogen storage specialist**
- **Fuel Cell specialist**
- **Robotics engineer**
- **Electrochemical engineer**
- **Industrial chemists**
- **Certification expert**
- **Hydrogen expert**

Roles written in **red** highlight an **urgent** need, expressed by multiple interviewees. This demand is currently met by young graduates or internal staff with no previous experience or specialised knowledge in hydrogen being trained internally from shared experience and in-house training.

5.3 ESCO Group 3 - Technicians and associate professionals

From the ESCO classification, tasks usually performed by technicians and associate professionals, and relevant for the hydrogen sector include:

"Undertaking and carrying out technical work connected with research and the application of concepts and operational methods in the fields of physical sciences including engineering and technology; initiating and carrying out various technical services related to trade, finance and administration including administration of government laws and regulations."

Technicians and associate professionals tree structure:

3 – Technicians and associate professionals

- **31 - Science and engineering associate professionals**
  - **311 - Physical and engineering science technicians**
  - **312 - Mining, manufacturing and construction supervisors**
  - **313 - Process control technicians**
  - 314 - Life science technicians and related associate professionals
  - 315 - Ship and aircraft controllers and technicians
- 32 - Health associate professionals
- 33 - Business and administration associate professionals
- **34 - Legal, social, cultural, and related associate professionals**
  - **341 - Legal, social, cultural and related associate professionals**
- 35 - Information and communications technicians

According to the interview campaign, there is a high demand for technicians:

- **Maintenance or service technicians**
- **Production technicians**
- **Testing technicians**
- **Higher technical degree in ship machinery systems**
- **Administrative staff from public institutions: governments, regions, municipalities**

Roles written in **red** highlight an **urgent** need, expressed by multiple interviewees. This major group is currently "in tension" or high demand and interviewees have expressed difficulties to find new personal for these roles.

5.4 ESCO Group 7 - Craft and related trades workers

From the ESCO classification, tasks usually performed by craft and related trades workers, and relevant for the hydrogen sector include:

"Constructing, maintaining and repairing buildings and other structures; casting, welding and shaping metal; installing and erecting heavy metal structures, tackle and related equipment; making machinery, tools, equipment and other metal articles; setting for operators, or setting and operating various machine tools; fitting, maintaining and repairing industrial machinery, engines, vehicles, electrical and electronic instruments and other equipment; making precision instruments, jewellery, household and other precious metal articles."

Craft and related trades workers tree structure:

7 – Craft and related trades workers

- 71 – Building and related trades workers, excluding electricians
- **72 – Metal, machinery and related trades workers**
  - 721 – Sheet and structural metal workers, moulders and welders, and related workers
  - 722 – Blacksmiths, toolmakers and related trades workers
  - **723 – Machinery mechanics and repairers**
- 73 – Handicraft and printing workers
- **74 – Electrical and electronic trades workers**
  - **741 – Electrical equipment installers and repairers**
  - **742 – Electronics and telecommunications installers and repairers**
- 75 – Food processing, wood working, garment and other craft and related trades workers

According to the interview campaign, no occupational profiles from this group have been mentioned by interviewees. We estimate that Task 2.2, thanks to its larger scope, will identify occupational profiles within this group.

5.5 ESCO Group 8 - Plant and machine operators

From the ESCO classification, tasks usually performed by plant and machine operators, and relevant for the hydrogen sector include:

"Operating and monitoring mining or other industrial machinery and equipment for processing metal, minerals, glass, ceramics or chemicals; operating and monitoring machinery and equipment used to produce articles made of metal, minerals, chemicals, rubber, plastics; driving, operating and monitoring mobile industrial and agricultural machinery and equipment; and assembling products from component parts according to strict specifications and procedures."

Plant and machine operators tree structure:

8 – Plant and machine operators and assemblers

- **81 - Plant and machine operators and assemblers**
  - **811 - Mining and mineral processing plant operators**
  - **812 - Metal processing and finishing plant operators**
  - **813 - Chemical and photographic products plant and machine operators**
  - 814 - Rubber, plastic and paper products machine operators
  - 815 - Textile, fur and leather products machine operators
  - 816 - Food and related products machine operators
  - 817 - Wood processing and papermaking plant operators
  - **818 - Other stationary plant and machine operators**
- **82 – Assemblers**
  - **821 – Assemblers**
- 83 - Drivers and mobile plant operators

According to the interview campaign, the demand in this major group is still relatively low but is expected to increase with the scale-up of the sector:

- **Workers/Operators in manufacturing**
- **Workers/Operators in maintenance**

6. Urgent skill needs

This section highlights specific skills required for the development of the hydrogen sector. They are presented here as they have been expressed by interviewees. Indeed, some "skills" are in fact specialisation topics. They are classified by level of urgency.

Based on the feedback from organisations interviewed, the most urgent skills needed on the labour market concern safety aspects. Out of 20 interviews, 7 contributors have expressed safety topics as a key aspect on skills. Skills expressed are:

- **"Risk and security management"**
- **"Safety and risks aspects of hydrogen projects"**

At a second level of urgency, three types of skills have been identified:

- **Technical expertise on specific topics associated with hydrogen.**
  - "Knowledge of polymer and inorganic chemistry for chemists and hydrogen experience"
  - "Expertise in electrolysers design, electrocatalysis, manufacturing and process"
  - "Advanced technical qualifications in mechanics, combustion, and generators"
  - "Liquification specialists"
  - "Material compatibility, aerodynamics, detection and simulation of leakage, combustion, and ignition, working with high temperature processes and objects"
- **Design of hydrogen projects and products:**
  - "Hydrogen projects engineering and designing"
  - "Designer of hydrogen installations"
  - "Compressors design"
  - "Project design"
- **Project development and management aspects:**
  - "Green hydrogen project management"
  - "Green hydrogen project development"

At a third level of urgency, skills mentioned once or twice through the interview campaign and are expected to play a significant role at a later stage of development are listed here:

- **"Understanding of the hydrogen market and value-chain"**
- **"Specialisation on each aspect of the green hydrogen value-chain:** Production, Logistics, Storage, Distribution, End-uses…

7. Status of hydrogen Occupational Profile demand

Based on initial inputs, Table 3 summarizes Occupational Profiles demand according to level of development of Green Hydrogen activities, across European countries covered in the first campaign of interviews of twenty contributors:

Research	Product Innovation	Project development	Manufacturing
- Highly qualified engineers and scientists with a Master's degree and PhD - Work in research centres, laboratories and universities	- Highly qualified engineers and scientists with a Master's degree and PhD - Work on developing new products or adapting existing products to hydrogen	- Experienced project managers, design engineers and financiers - Hydrogen production, transport, storage and distribution companies	- Specialists in all technical areas, both engineers and technicians - Material suppliers, equipment manufacturers, EPC, operation and maintenance companies
▪ Czech ▪ Romania ▪ Ireland ▪ Slovakia	▪ Finland ▪ Italy ▪ Switzerland	▪ Italy ▪ Austria ▪ Belgium ▪ Finland ▪ Estonia ▪ Poland	▪ Netherlands ▪ Italy ▪ Greece

Table 3: Initial Occupational Profiles demand

8. Conclusion

To summarize findings from this task 2.1, we can conclude that there is a lack of specific hydrogen education and training programs in all countries interviewed. Companies developing their activities in hydrogen generally have difficulties finding people with previous hydrogen experience, knowledge or experience. Demand for engineers and technicians is high. This is reflected in difficulties to find technical staff in most sectors covered. Specific hydrogen expertise is currently rare in the EU labour market. The demand for engineers is met by personal with an engineering title or a Master's degree from a technical university, without hydrogen specialisation. The demand for technicians is hardly met. This issue has been expressed among various industries and is not specific to the hydrogen sector. However, the scale-up of this industry will reinforce demand in the labour market for these roles. On-the-job training, shared experienced within teams and internal knowledge accumulation are currently addressing the gap of hydrogen qualifications. Looking specifically at skills, industrial players are mainly concerned about the technical and safety aspects of hydrogen in their demand for qualified personnel.

The need for hydrogen education has also been identified within public actors (e.g. government or local officials) across all levels. The lack of competences of these actors, specifically regarding safety and risks aspects of hydrogen projects can be a burden for the development of the sector. Indeed, these occupational profiles have no previous experiences with such projects but regulatory approvals and permits from public actors will be

needed to move ahead. d Hydrogen training is necessary from local to global policymakers, in order to define and implement strategies, public fundings and regulatory approvals.

This first output on occupational profiles and skills needs for the hydrogen sector will be complemented by a second phase of interviews, targeting 100 contributors, with a more detailed analysis to enable the development of a dedicated Skills Strategy.