GREEN WELD

FINAL REPORT

Need Analysis report, Skills and Learning

Revision	Date	Author/Organisation	Description
1st	30/05/2023	CESOL, EWF, QI, SATB	FIRST ISSUE
2nd	20/09/2023	WGI	FINAL
3rd			

Contents

1. EXECUTIVE SUMMARY

This document is the Final Report of Work Package No 2, Current Green Skills needs and Learning Approaches for Welders, of the GREENWELD project. It presents and analyses all actions made for reaching the goal of WP 2, recognize and identifying the green skills Needs and innovative training approaches, for welders increased green mentality and awareness. The aim of this report is to release recommendations for skills and learning methods.

For identifying the Current Green Skills needs and Innovative approaches for Welders, actions were made to gather the needed facts, we proceed to "green gaps identification" meaning topics that can be changed, replaced or added, and identifying the green tools which can be used as tools to fill these gaps and reach the goal for Green Welding Certificates.

For the above-mentioned purposes our research was divided in two parts.

First by using "firsthand data".

Questionnaire Survey for Industry companies occupied with welding processes and for welders Training organization, were distributed, as a first step to better understand the current situation, the green gaps arise in those sectors and ways/solutions to fill these gaps to a Greener Welders Attitude. The results from the Questionnaire surveys are presented in paragraph 3.

And by using "existing data"

Desk research took place by Project's partners, in our effort to find more elements useful for implement a new innovative training guideline, completed adapted to Welders; green training and mentality. The Desk Research focused on the existing EWF Welders training guideline, for finding the topics that may change to greener, or topics where green adds may occur. The sources for these adds, more the survey results, found also on ISO documents describing environmental quality requirements and ongoing ERASMUS projects dealing with relevant issues. The Desk research made is in detail present in paragraph 4.

All gathered results were validated, to final recommendations occur, by a Roundtable event where experts from Industry and Training sector state their professional opinion in accordance to their working experience. The Roundtable conclusion and validating of the results process is presented in paragraph 5.

2. TERMS OF REFERENCE

GREENWELD: Green Welding Certificates, Project acronym

VETs Centers: Vocational Education and Training Centers

EWF: European Welding Federation

GreenComp: The European sustainability competence framework

DigComp: Digital Competence Framework for Citizens

EfVET European Forum of Technical and Vocational Education and Training

EARLALL European Association of Regional & Local Authorities for Lifelong Learning

EAEA European Association for the Education of Adults

SDG Sustainable Development Goals

ESCO European Skills, Competences, Qualifications and Occupations

3. SURVEY QUESTIONAIRRIES

Questionnaire Survey for Industry companies engaged with welding processes and for welders Training organization, were distributed, as a first step to better understand the current situation, the green gaps arise in those sectors and ways/solutions to fill these gaps to a Greener Welders Attitude.

3.1 Industry Survey

A total of 39 answers were obtained from companies in the industrial sector that are in daily contact in the field of welding. The results are shown below according to each of the sections that were asked, in order to try to focus more precisely on the results to be obtained and decisions to be taken during the development of GREENWELD project.

– Country where the company, answered the survey, is based:

Spain:33.3% -13 answers

Greece:35.9% - 14 answers

Romania: 5.1% -2 answers

Portugal: 7.7%- 3 answers

Poland: 2.6%-1 answers

Netherlands: 2.6% -1 answers

Hungary: 2.6% -1 answers

Demark: 7.7%-1 answers

Latvia: 2.6%-1 answers

Colombia: 2.6%-1 answers
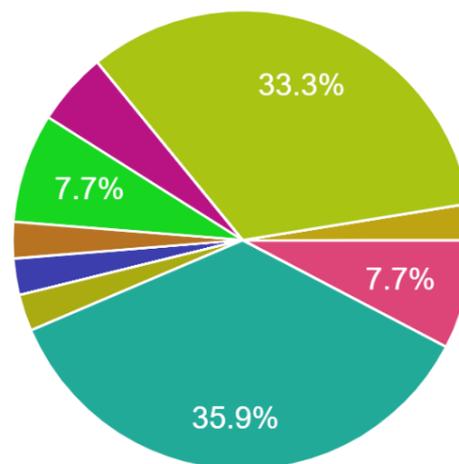
Total answers received: 39   90% from Europe and 10% from other continent

– Company personnel answering the survey:

- 🔵 Owner/ Legal representative/ Technical Director
- 🔴 Site Manager
- 🟠 Employee
- 🟢 Other
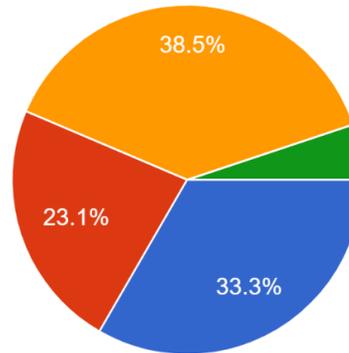
– Qualification and Certification Background of welding personnel within the company:

International Welding Engineers: 66.7 % – 26 answers

International Welding Technologist: 15.4 % – 6 answers

International Welding Specialist: 23.1 % – 9 answers

International Welding Practitioners: 2.6% – 1 answer

International Welding Inspection Personnel :25.6% – 10 answers

International Welder: 17.9 % – 7 answers

European Welder Operator: 12.8% – 5 answers

No Welding Qualification:12.8 % – 5 answers

No Qualification but Trained with the Company: 2.6 % – 1 answer

Certified Welding Engineers/ Certified Welding Inspector/ Certified Welders per AWS: 2.6%–1 answer

Certified Welders in accordance with ISO 9606 and ASME: 2.6 % – 1 answer

– Size of the Company answering the survey:

Nº of Employees involved in welding activities
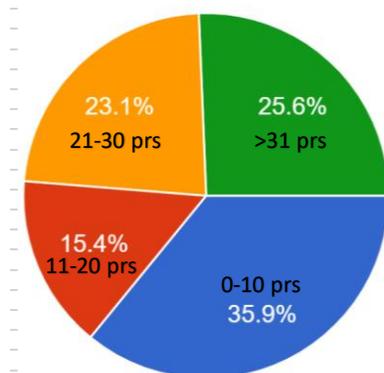
Nº of welding machines
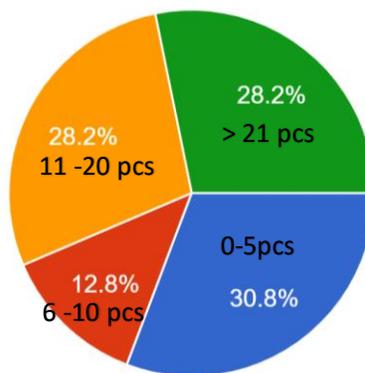
Raw metal consumption per year
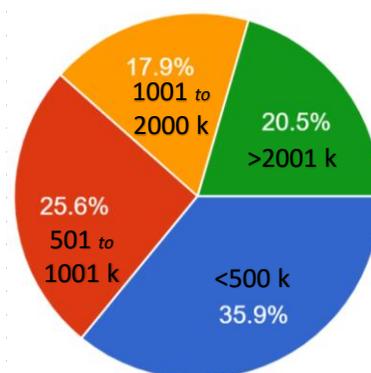
– Welding Certificate Scheme that the company comply with:

ISO 3834: Quality requirements for fusion welding of metallic materials: 53.8%- 21 answers

EN 15085: Railway Standard – Welding of railway vehicles and components 20.5% - 8 answers

EN 1090: Structural steel and aluminium: 30.8%-12 answers

None: 38.5% - 15 answers

– Is you Company comply with ISO 14001 (Environmental M.S.):

- 🔵 Yes
- 🔴 No
- 🟠 Yes, and with other International/ European/ National Requirements and/ or Legislation
- 🟢 No, but with other International/ European/ National Requirements and/ or Legislation
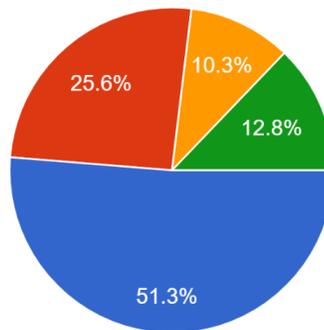
Yes, in total: 61.6 %

No, in total: 38.4 %

If No please specify:

- Certification procedure in progress
- We would like to implement the environmental regulations by 2023
- We are an Examination and Certification Body
- It is not mandatory for our clients
- It was never requested.
- Not Applicable

–Green Internal Procedures followed by Companies:

- Recycle waste after welding (metal scrap, welding consumable etc). 76.9%-30 answers
- Use of fewer raw material. 25.6%-10 answers
- Use renewable energy 25.6%-10 answers.
- Use smart manufacturing Software 15.4%- 6 answers.
- Update regularly, your Machinery and/or Equipment. 46.2%-18 answers.
- Use means for controlling gas emissions during welding procedures. 17.9%-7 answers.
- Use means to control energy consumption. 17.9%-–7 answers.
- Analyse your environmental Impact of your welding processes 12.8%- 5 answers.
- Raise awareness for environmental issues or procedure. 48.7%-1 answer.

– Companies answered the survey, better describe Green Mentality as…:

- Reduce costs from the Fabrication procedure 59%-23 answers.
- Improve production efficiency 59%-23 answers.
- Create a healthier working environment 74.4%-29 answers.
- Will increase working manhours 5.1%- 2 answers.
- Will require more staff and/or equipment 10.3% - 4 answers.
- Will decrease daily welding production 10.3%- 4 answers.

– Intention of Companies to invest in green welding procedures by…:

- Invest in more equipment 12.8% - 5 answers.
- Invest in more efficient equipment 61.5% - 24 answers.
- Revisit communication and organizational flows in order to become more efficient 23.1% 9 answers.
- Introduce special green procedures for welding activities, in addition to the mandatory ones (by National Legislation or National / International Standards). 43.6% -17 aswers.
- Train the welding personnel within greener approaches 74.4%- 29 answers

3.2 VETs Survey

A total of 32 answers were obtained from VETs centres that are in daily contact in the field of training in welding. The results are shown below according to each of the sections that were asked, in order to try to focus more precisely on the results to be obtained and decisions to be taken during the development of GREENWELD project.

– Country: Total answers received: 32, 90% from Europe and 10% from other continent

Romania: 8 / 25%

Portugal : 5 / 15.6%

Poland :1 / 3.1%

Hungary: 3 /9.4%

Greece: 4 / 12.5%

Germany : 1 / 3.1%

Denmark: 4 /12.5%

Croatia : 1 / 3.1%

Spain: 3 / 9.4%

Switzerland: 1 / 3.1 %

Turkey : 1 / 3.1 %
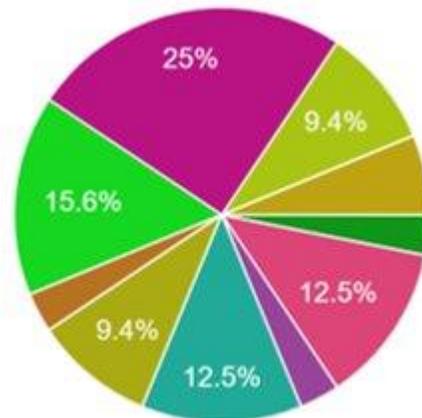
– VET Personnel answering the survey:

- Owner/ Legal representative/ Technical Director
- Site Manager
- Employee
- Other
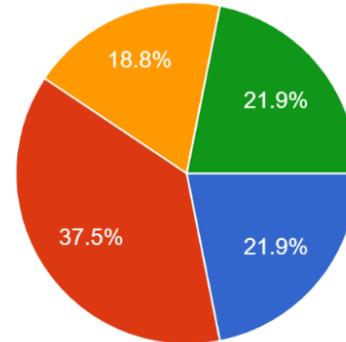
– Type of training Organization answering the survey:

- Vocational Education and Training Centre (public)
- Vocational Education and Training Centre (private)
- Training Unit/department (with in company)
- Secondary School
- University
- Other
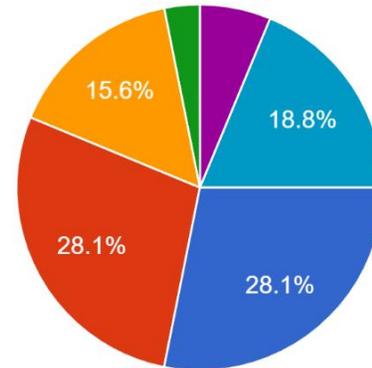
VET / public: 9 answers
VET / private: 9 answers
Training within Company: 5 answers
Secondary school: 1 answer
University: 2 answers
Other: 6 answers

– Experience of the Organization (in years):

- 0 – 4
- 5 – 10
- 11- 15
- More than 15 years

56.3%
18 / < 15y

4/ 0-4y
12.5%

5/ 5-10y
15.6%
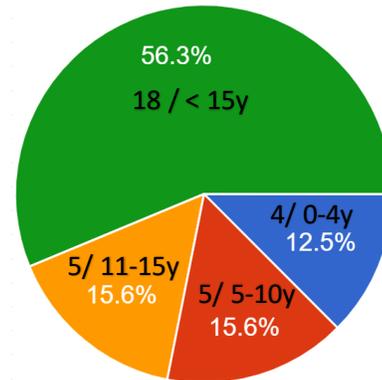
5/ 11-15y
15.6%

More than 15 Years: 18 answers.

11 – 15 years: 5 answers

5-10 years: 5 answers

0-4 years:4 answers

–Which Teaching Methods are used for Welders:

31.3%
10 answ

12.5%
4 answ

1 answ

17 answ
53.1%
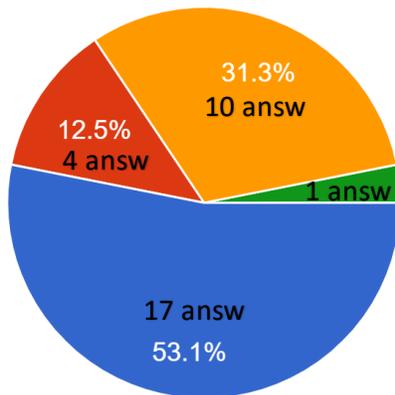
- On site and traditional lessons, for both theoretical and practical subjects
- Online lessons for theoretical and on site for practical subjects
- On site lessons using digital resources, both for theoretical and practical subjects
- Other

– Which Digital tools are used in Welders Training:

- E-Learning platform 59.4 %-19 answers
- Training Applications 40.6%-13 answers
- Digital games for educational Purposes 18.8%-6 answers
- Practical exercise simulators 65.6% - 21 answers
- Augmented Training Methodology 31.3% - 10 answers

– Environmental Control in Training for:

Energy Consumption
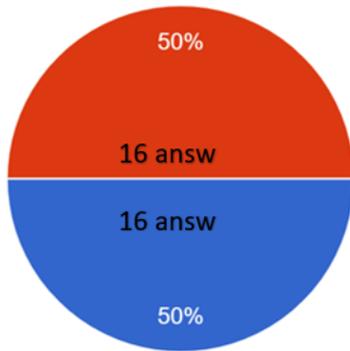
Gas Emissions
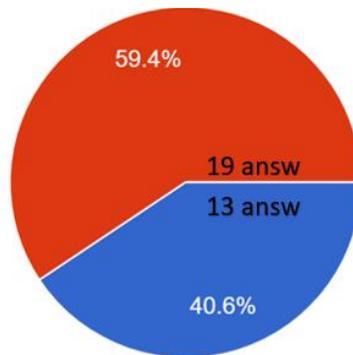
Reduced your raw material consumption per student (last 4 years)?
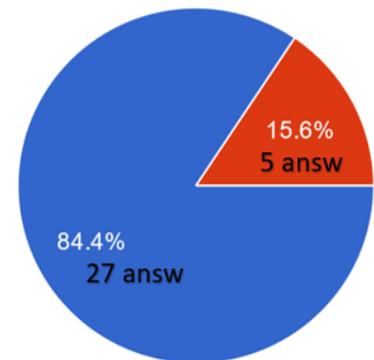
If Yes, by which measures?

- Reduction of direct costs: 51.9% – 14 answers
- Reduction of material waste: 92.6% – 25 answers
- More digital manual: 3.7% – 1 answer.

– Do any special procedure of handling the waste after Welders Training, is used?:
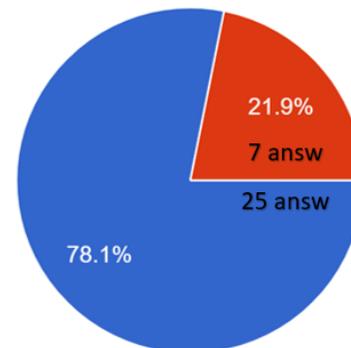
If, please specify which:

- Recycling Metals
- Waste are classified and given to the waste collectors
- Hazardous waste are recycling waste
- PG-ISQ/12 – Legal requirements for Portugal.
- Reuse of the material.
- proper waste segregation.
- Recovery of basic materials for another training.

If No, Please Specify:

- No need.
- Standard cleaning practices and PPE for waste after welder training. No need for special procedure due to the relatively low number of welding operators trained (between 20 to 50 per year in different time period sessions).
- Samples are collected to be recycled.
- The institution sells waste for scrap, probably for recycling.
- Standard waste disposal
- we have one, but our of news norms

– Is Green Welders Training, Upgrade capacity and effectiveness in their work and productivity?
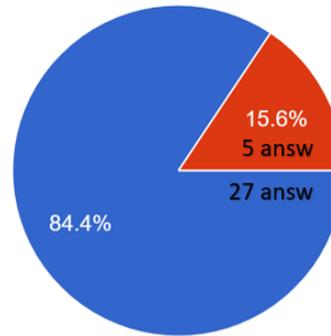
How?

sustainable processes, environmental protection, greener mentality, environmental respect, combination of a simulator based on digital reality technologies and real welding, reducing waste.

– Is your Organization Positive in investing in Environmental Welders Training?:
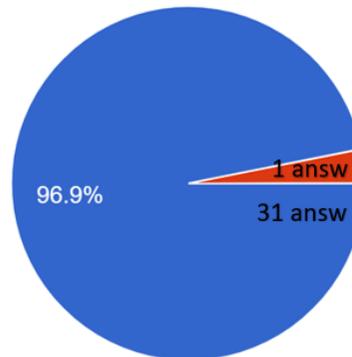
How?

competence building, welding simulators, welders training platform, solar energy, tools based on digital reality, new forms of energy, recycling, Online training

4. DESK RESEARCH

The Desk Research plays a crucial role in the beginning stage of Greenweld project, as it is an essential component in project initiation by summarizing with relevant knowledge, insights, and solid foundation to build upon. It enables the project team to identify gaps and opportunities and set the stage for effective planning and implementation of the project.

The Desk Research is based on three main documents, with the goal of identify the constrains, the needs and opportunities in in the following reference documents:

- European Welders and Welders Operators curriculum
- ISO 14001/ Environmental Management Systems and ISO 45001/ Occupational Health and Safety Systems
- GreenComp and DigComp

4.1 European Welders and Welders Operators curriculum

Regarding the curriculum of the European Welders and Welders Operators, a revision of the European Mechanized, Orbital and Robot Welding Personnel (EMORWP) training guideline and the European Welder, Part I and Part II training guideline, allows to identify whether we can add green skills to the curriculum and if it reflects the possibility to add green scope, and how to do it.

The main conclusions are mapped below:

| **Related with Curriculum**	**Related with Training delivery**
☐ Specific and complementary Competence Units dedicated to green skills can be add	☐ Parts of the curriculum can be delivered with auxiliary tools , e.g simulators, AR/VR tools
☐ It is difficult to add contents to the competence units without shanging the hours	☐ Training can be delivered in B-learning
☐ Possible changes can ever compromise the quality of the course	☐ Active learning can be an add value (e.g. case studies)

Figure 1 - Main conclusions in the revision of the European Welders and Welders Operators guidelines

In addition, a working session with an Expert in joining technologies and, most of all, expert in managing the international harmonised system for education, training and qualification in this field was provided.

The main topics are below:

Working Session with Expert

- [ ] B-learning is already preview in the training

- [ ] To develop a baseline of relevant concepts about sustainability (relevant for the project Greenweld and relevant for the training/industry

- [ ] To develop a competence unit dedicated to green skills

- [ ] To map out the relevant competences for the metal fabrication in welding and set possible gaps. If possible gaps are mapped, develop a specific competence unit for this purpose

- [ ] To address green skills in the elementary and basic level

Figure 2 - Working session with Expert main conclusions

Greenweld desk research on the training guidelines combines two general tasks: to identify "green gaps" and the topics that can be added to fill in those gaps, in the scope of welding training and production. The Recommendations are list in page 26.

4.2 ISO 14001/ Environmental Management Systems and ISO 45001/ Occupational Health and Safety Systems

Following, the Greenweld Project desk research analysed the International Standards reference documentation, that promote consistency, safety, and quality across different industries. These standards, as a guidelines and best practices examples, support the desk research in the areas of environmental management and heath and safety.

ISO 45001 specifies requirements for an occupational health and safety (OH&S) management system, and gives guidance for its use, to enable organizations to provide safe and healthy workplaces by preventing work-related injury and ill health, as well as by proactively improving its OH&S performance.

ISO 14001 deals with environmental compliance of management systems that an organization can use to enhance its environmental performance.

ISO 14001 displays a commitment to the environment, while ISO 45001 shows a commitment to an organization's employees and all interest parties that could be affected by an organization.

Although both above mentioned ISO documents are developed in such a way that they do not identify any organization type, process or product, they could easily be adopted to Greenweld Project. Identifying Greenweld stakeholders (welders, trainees, trainers, VETs, Industry Organizations, persons that could be affected from the welding process) we can adjust the ISOs' requirements by add them to the new training syllabus and applying them to our new green innovative mentality.

The potential exploitable elements of ISO 14001 and ISO 45001 are summarised in the table 1:

ISO DOCUMENT	REQUIRMENT
45001	- Understanding the organization and its context such as, the cultural, social, political, legal, financial and technological nature, new technologies, new laws; new knowledge on products and their effect on health and safety; key factors having impact on the organization; relationships with its external interested parties; organizational structure and roles; policies, objectives and the strategies introduction of new products, materials, services, tools, software, premises and equipment; outsourced activities; working conditions; - Actions to address risks and opportunities - Opportunities to improve worker's performance - Hazard identification process - Competence for each role in the Organization the education, training, qualification and experience
14001	- Organization's context regarding environmental conditions related to climate, air quality, water quality, land use, existing\contamination, natural resource availability and biodiversity, that can either affect the\organization's purpose, or be affected by its environmental aspects - The external factors that may affect the Organization - Stakeholders be affected by the organization's decisions or activities related to environmental performance - Environmental policy - Environmental risks and opportunities - Determining potential emergency situations - Environmental aspects e.g. emissions to air, releases to water; releases to land, use of raw materials and natural resources, use of energy; energy emitted - Environmental aspects related to the organization's activities - Compliance obligations and environmental competency requirements - Awareness of the environmental - Performance evaluation

Table 1 - *Potential exploitable elements of ISO 14001 and ISO 45001*

By implementing ISO 14001 and ISO 45001, organizations can align their environmental and OH&S management systems with the principles of the green transition. These standards provide a structured approach to manage environmental and occupational health and safety aspects, ensuring a smoother transition towards sustainable practices and contributing to the broader goals of a greener future.

4.3 GreenComp and DigComp

GreenComp, an initiative by EfVET (https://efvet.org/) ,EARLALL (https://www.earlall.eu/), and EAEA (https://eaea.org/)[1] , advocates for civil society involvement and multilevel governance in the European Competence Framework for Green Skills. It seeks to ensure timely publication and successful implementation of this framework.

GreenComp emphasizes the need for active policies and practices to provide workers and citizens with green skills to help deliver the European Green Deal. Lifelong learning, Adult Learning and Education, and Vocational Education and Training (VET) can contribute to this by defining and implementing green skills with a bottom-up approach. These organizations play a crucial role in equipping citizens with the necessary skills for personal and professional development. Green skills should be mainstreamed and incorporated into education policies and practices through a common GreenComp framework, including adult education and VET, to create a skilled labour force for sustainable development and growth.

The conclusions that can be applied as a starting point for Greenweld Project and its goals: to upgrade the training of welders and also companies to improve their facilities and work process to become greener, are listed below:

- Facilitate and improve the implementation of work-based learning and work-placed learning, peer-learning and training opportunities for VET practitioners;
- Promote a green culture among education establishments and industry, with harmonised training and guidelines in all countries that want to train welders;
- Modify welders training guidelines/curricula that include and mainstream green skills, with the introduction of theoretical content on the storage, reuse, recycling and disposal of waste and materials used in welding;
- Respect sustainability principles and the environment;
- Implementation of digital trainings, such as welding simulators and online platforms where trainees can study and be assessed, allowing the reduction of raw materials required and waste generated in welder training such as paper, metals and fumes, as well as the reduction of costs associated with training in terms of energy and time;
- Taking into account the 2030 Agenda and SDGs (Sustainable Development Goals) into the mission of education establishments across Europe, mainly the topics number 4 (Ensure inclusive, equitable and quality education and promote lifelong learning opportunities for

all), 9 (Industry, innovation and infrastructure), 10 (Reducing inequality within and between countries), 12 (Ensuring sustainable consumption and production patterns), 13 (Take urgent action to combat climate change and its impacts) and 15 (Sustainably manage forests, combat desertification, stop and reverse land degradation and halt biodiversity loss).

In additional, Greenweld Partners identified the parallel between the digital transition and the green transition. Organizations and policymakers can leverage the potential synergies between both, to drive sustainable change.

A detail analysis of the pillars of DigComp can provide the skills needed to be competent in digital environments and describes them in terms of knowledge, skills and attitudes and provides the levels within each competence.

The competence areas that are identified in DigComp are the following:

Figure 3 - *DigiComp competence areas for digital environments*

In summary, the framework identifies key components of digital in 5 areas and each area has 3 levels of knowledge, basic, intermediate and advanced. The areas are detailed in Annex I.

After a comprehensive analysis using the Digicomp framework, it is evident that a significant opportunity exists to align the welders' curriculum with green and digital practices. By incorporating key competence areas and levels of knowledge related to sustainability, we can cultivate a workforce that actively contributes to environmental preservation and resource efficiency.

Based on the analysis of the Digicomp framework, it is recommended that the welders' curriculum undergo necessary modifications to incorporate these key competence areas and levels of knowledge related to green and digital practices. By doing so, we can equip welders with the skills and awareness needed to support sustainable development and contribute to a greener future.

5. ROUNDTABLE

5.1 Roundtable Event

An roundtable was organized on 9th of May 2023 with experts from the Industry and Training sector, introducing Greenweld Project to the participants and giving the opportunity for all attendees to state their professional opinion while brainstorming in different sectors, totally connected (training and industry by qualified personnel).

5.2 Aim of the Event

The aim of the event is to validate the results gathered from all the previous actions made by Partners, specifically:

A. Results from the answered surveys for Industry;

B. Results from the answered surveys for VETs;

C. Results from Desk Research, based on analyzing ISO Documents and Erasmus projects related to Green skills and needs, and EWF existing Training Guidelines.

5.3 General Discussion

Greenweld project focuses on both in Industry and Training Sector. The meaning of the Green Welders Certificate varies, in accordance to each stakeholder's professional prospective and experience. A general indication for Green Welding Certificates is understood and their aim, are presenting below.

"Green Welding Certificate" are understood as:

- A Certificate document, issued in a digital format and not as a hard copy.
- A certificate issued for a welder, which is based on welders' skills to apply the welding process with a green awareness, such as control gas emissions.
- Is it not understood as a Certificate, but as a process which is focused on environment, from a prospective of research, such as Providing materials that is not toxic or pollutant and robotization which will decrease pollutant emission, and from education perspective as it is considered an added value from the green transition.
- Exchange from old welding mac to new one is very energy critical. Big possibility of getting energy back by new machines. Has a huge impact with education. The quality of the weld should be good in the first shot and not have the need to do repairs and re welds. Support with digitals tool etc can be a good way to avoid this. Less material consumptions.

Advantages of Green Mentality, connected to other topics than environment.

- It was mentioned that it is a way of life, general attitude, respect for life not only for the environment, an attitude of not wasting but re-consumption, and
- That, nowadays, is a matter of survival.

Greenweld results added value, both in Training and Industry are:

- Well trained personnel is always an added value to an Organization/ Company.
- Respectful behavior not only in the environment but also in a social context, upgrades the whole of a company.
- A revised educational instruction or guideline, using green learning methodology, will lead to conscientious Diploma holders and could reduce educational costs.
- Personnel with green mentality could socially upgrade a company and reduce their productivity costs.

"Green training tools" in welders' training are understood as:

- Welding simulators may be used as the first training practical part, e.g. setting of the correct parameters to the power source.
- Welding simulators may be used for 30% of the practical welders training
- Usage of e-learning platforms and e-books

Industry sectors may became greener by:

- Different, than usual, forms of gases used in welding process.
- Give specific instruction, guidance to direct personnel, for greener actions.
- Release and implement internal procedures of the organization to be greener, such as recycling, re-use .
- Occupy trained stuff, with increase green awareness and mentality

5.4 Validation of Survey Questionnaire results for Industry Green Needs

For identifying the Green Needs for Welders in Industry sector, a survey questionnaire was distributed to Companies, covering 8 Industry sub sectors, where the welding process is considered critical. The industry sub sectors were Marinetime & Naval, Refineries/Petrochemicals Plants, Aeronautics, Vehicles, Steel Structures, Railways, Energy & Renewable energy and Aquaculture & Agriculture.

The total answers received are from 39 Industry Companies.

90% of the Companies answered are based in Europe, giving a realistic image of the Green Needs in Europe.

66.7% of the persons answered the survey are occupied in the Company, as indirect or direct personnel.

Up to 66.7% of the Companies are stuffed with trained and Qualified personnel involved in welding process.

About 50 % of the companies occupy more than 20 persons for their welding needs, with more than 10 welding machines (manual & automatic), consuming more that 1001 kilos of raw material per year and complying with Quality Certification Scheme regarding Welding.

63 % of the Companies are Complying with ISO 14001, Environmental management systems or with other International/ European Requirements and Legislation, reaching the 75% of environmental compliance.

Companies not complying with environmental requirements at the current time, is because they are in process of issuing the ISO 14001 certificate, or it is planned until the end of 2023, or they suppose is not mandatory for their activities and/or their clients, or it was never requested so they didn't t proceed to any actions. During the Roundtable event it was validated, that the potential reasons for a Industry company occupied with welding process, not complying with Environmental Quality Management System or/and relevant Requirements and Legislation are, indeed, that it was never asked/required by Clients/ Project and the Owners are not proceeding to Certification as they consider it is not mandatory. It was also mentioned that Certification costs a specific amount, or because the Company cannot comply with the Environmental Requirements.

Based on the results of the Industry Survey Questionnaire the most common procedure that a company may apply to be greener and more environmentally friendly are: Recycle waste after welding (metal scrap, welding consumable etc), Use Renewable Energy, Use means for controlling gas emissions during welding procedures and energy consumption, Analyze the Environmental Impact of the applied welding processes and Raise awareness for environmental issues or procedures. Following is to locate Recycling points, use procedures for paper handling, and products such as oil, paints etc.Use of fewer raw material and Smart Manufacturing Software are also in list but not considered that common and last updating regularly, Company's Machinery and/or Equipment is the less common green action in Industry Companies. Although the activities of recycling and/or reducing the raw material consumption is placed as one of the most common procedures, a key supporting idea was that it may have less impact, as the Industry companies are already trying to limit their materials' costs.

Within an Industry company a green mentality is better described as a healthier working environment, which will require more staff and/or equipment and will decrease daily welding

production.It was also mentioned that a green mentality will increase working manhours occupying in welding process (indirect – direct personnel), but in a smaller scale. It was not agreed by the majority that a greener mentality will improve the production efficiency and will reduce Costs from the fabrication procedure.

Regarding the Investment intentions of a Company for Environmental proposes, the most productive and effective investments is considered to invest in more efficient equipment, to introduce special green procedures for welding activities, in addition to the mandatory ones (by National legislation or National /International Standards) and to train the welding personnel with greener approaches. Revisit communication and organizational flows to become more efficient, is not considered as critical as the above mentioned, and just investing to equipment is considered to have to lowest productivity impact.

5.5 Industry Survey Questionnaire Conclusions.

Although ISO14001 is not mandatory by International / National legislations and/ or European Directives, a very large percentage of Industry Companies are complying with it. There is an intention of the companies not complying, to start in the very near future to start, or are already in process, the Certification process to comply with Environmental requirements. The cost of the Certification process is a small issue for Companies, but it is not considered as the main cause for not complying. It was agreed that the most obvious reason for a Company not to Comply with Environmental Requirements is that indeed does not meet the requirements/criteria.

 Health is considered one of the major factors, for a working environment and we agree that it can be strengthen when related to green mentality and respect to environmental issues. Besides that, the general impression that a green mentality gives, is the issue of productivity and working costs. It is considered that it will increase man hours and daily costs and it will decrease the daily welding production.

Persons answering this survey, in about 67% are stuff of Companies and not Owners. That gives us a not realistic picture of the investment intentions of a Company, as in most cases the decision-making people are the Owners. We can verify the logical prospective that an investment in more efficient equipment, especially if apply new technology practices, will improve the environmental attitude of a company. Furthermore, specific green procedures and instructions during welding production by trained personnel are also considered an added value for a company.

Changing Organization chart, is though as non-mandatory, even that a company should act as one Organization, per example if Managers act greener, having green mentality and apply green procedures the other employees is more probable follow too.

Validation of Survey Questionnaire results for VETs Green Needs and Training Approaches

VETs Survey Questionnaire was distributed to Training providers to identify not only the green needs but also means of improvements to develop green skills in welders and help companies to became greener.

The total answers received are from 32 Training Providers,

90% of the Training Organization answering the Survey are based in Europe, giving a realistic image of the European situation.

22% of the persons answered the Surveys are Training Organization Owners.

About 28% are Public Organizations, while the rest are private schools, training departments within Industry Companies and schools.

Almost 60% of the Training Organizations have more than 15 years of welders training experience.

More than 50% of the Training Organizations are implement on site and traditional lessons for both theoretical and practical welders training, and only 12.5% are using online lessons for theoretical and onsite for practical subjects.

Regarding the methodology and innovative means for welders training, focusing to be more environmental friendly and become greener the following are stated.

It is easier for a training organization to change/ upgrade their teaching methodology to be greener, if it is a new Organization (in terms of years of experience), as they do not have to change and pass through an adjustment period (change mentality, change equipment etc), but start in a zero base.

After Welders' Practical Training, Organizations are reusing the raw materials. In this way they reduce the raw material consumption, and the needed materials 'costs, but they do not connect these actions with green mentality.

Training Organization's personnel, specifically trainees, occupied with practical training of the welding process, find difficult to teach with welding simulators.

E-learning platforms, practical exercise simulators and augmented training methodology are the most effective digital training tools and also support the green Training methodology. Digital games for training proposes are also effective and it is a way of exercising the student memory.

Reduction of raw material consumption per student during his training, can lead to reduction of direct costs and material waste. Digital manuals, e books etc, are included in the "reduction of direct costs".

"Reuse of materials and Recycling Metals after training" is better describes that "a green procedure of handling the waste after welders training"

The green added value to Welder's training, is that the training procedure should be a sustainable processes with environmental respect, should combine a simulator based on digital reality technologies and real welding, Sensibilization on waste consumption in everyday life and the importance of circular economy and Greater green awareness on the part of teachers and students of the importance of reducing waste both in economic and environmental terms.

A potential green investment, common accepted, for Training Organization is the usage of Solar energy, Training platforms and welding simulators.

5.6 VETs Survey Questionnaire Conclusions.

Training Organization occupied with Welders training, are currently use digital means mostly for the theoretical part of the training. Some of them are using welding simulators and are willing to invest to such equipment for providing a greener practical training. Furthermore, they follow recycling and reuse of metrials procedures as environmental frindly actons and also to reduce the educational costs. Besides virtual means for training, simulators, e-lerning, e-books, gamification, there is an intetion to take advantage of the solar and other renewable energy sources, but always taking into account the missing funds and the potential expensive investment. It should be noted that Oragnizations with a lot of years of training experience, may try more to absorve a green mentality since they have to experience a big change. The other issue is that for public Organizations, a change have to come by Governemental authorities, as they cannot act within a more freely contex as privet schools or educational cenetrs.

5.7 SLIDO – POLL RESULTS

During the Round table event questions to participants were made as follow

- "What gaps still need to be address for the green skills".

This question addresses the Industry and Training sector and intend to rank the given answers. 18 participants answered.

1. Lack of awareness among employers, was ranked at the top with 2.1 points.
2. Inadequate integration of green skills into education system, was ranked second with 1.4 points
3. Limited availability of training programs, follow with 1 point.
4. Rapidly evolving of green jobs, with 0.9 points
5. Lack of standardized definitions and frameworks, with 0.5 points.

After listing the green gaps, we understand that awareness is the most critical factor as a green skill, following the importance of entering the green skills into the educational systems. I seems that even if standardized definitions and frameworks are available, it will not fill the green gaps without awareness and training.

- "What gaps do you experience between your current activity and the green skills"?

This question addresses the Industry and Training sector, and it was an "open text" poll for participants to state their opinion. 14 participants answered.

6. Lack of awareness is place first again with 7 participants.
7. High Costs for green processes, follows stated by 5 participants.
8. Lack of funds, to invest to greener mentality, stated by 2 participants.
9. Lack of knowledge of which are the critical parameters which are most efficient to measure or work with. Stated by 2 participants.
10. Lack of tools for measuring the critical parameters. Is stated by 1 participant

Again, green awareness if the first to come to mind, considered critical factor to change. Following the issue of costs and fund to make green investment, we also dealing with the lack of knowledge of the parameters creating the green gaps and how we will deal with it (e.g. means) if we do not understand it.

- "What knowledge is missing in the green transition, for the Welders? "

This question addresses the Industry and Training sector, and it was an "open text" poll for participants to state their opinion. 11 participants answered.

Green behaviour, Awareness, Recycling - Reuse, Green Training, Energy performance improvement, emission reduction, online tools, their own impact.

- "What practical cases would you like to find in the training of welders (from he perspective of green skills)"

This question addresses the Industry and Training sector, and it was an "open text" poll for participants to state their opinion. 15 participants answered.

Recycling and waste reduction, Online learning for theoretical training, saving energy, reduce material consumption, welding simulators combined with blended learning.

6. CONCLUSIONS

In this final section, we are trying to narrow down the main conclusions and recommendations form the research conducted so far throughout workpackage 2 in the Green Welding project. The aim of this report was to analyze and interpret the findings from the various types of research, shedding light on the key insights and implications they hold for the future work for this project.

However, it is important to note that while the conclusions and recommendations presented here are based on the research and analysis, they are not intended to be definitive or exhaustive. Instead, they should serve as a starting point for further exploration and discussion within our project group. As new information emerges and circumstances evolve, it will be crucial to reassess and adapt our approach accordingly.

6.1 Conclusion

Throughout the research phase, a striking disparity between the approaches and perspectives of Vocational Education and Training (VET) and the industry regarding the green transition has become apparent. It comes as no surprise that the two types of organizations have distinct requirements, leading to the observed differences. Additionally, the research findings likewise indicated a substantial variation in needs and requirements among industries, influenced by factors such as customer demands, legislative frameworks, and other relevant aspects. Hence, to develop a successful certification program, it is crucial to ensure that it comprehends the needs and requirements of both VET and the industry.

Despite the notable differences observed, a central takeaway from the research phase remains consistent across VET and industries. One of the main findings from workpackage 2 underscored the significance of enhancing awareness, and a competence unit, to raise the awareness about the green transition as a key determinant in achieving a successful certificate. Both VET and industries emphasized the need to improve awareness at all levels, recognizing that it should not be limited to management alone. If real changes should be successful, awareness and engagement must be forwarded throughout the entire organization.

When discussing green awareness, it is crucial to prioritize increasing general awareness within the organization. This involves ensuring that others in the organization have a clear understanding of what is important, why it is important, and, most importantly, how it is specifically accomplished. Awareness is an essential part as it marks the starting point for any new transition. Without understanding and empathy it becomes challenging to implement new standards.

In addition to emphasizing the significance of awareness, several other aspects were identified during the research phase. These findings can be categorized into four subheadings: *Energy, Gas, and other consumables; Welding techniques and equipment; Material usage and reuse; and Education.*

6.2 Energy, Gas, and other consumables

During the research, participants emphasized the significant importance of learning how to measure, handle, or reduce energy use, gas usage, and the usage of other consumables in order to promote greener welding practices. Both VET and industry stakeholders share a common understanding of this importance. By reducing the consumption of these resources, not only can CO_2 emissions be decreased, but costs can also be minimized, benefiting both VET training and real production scenarios.

Furthermore, the research also highlighted the importance of understanding the availability of different options for gases and other consumables, and more importantly, how these options differ from one another. Having knowledge about the various options in the market and their comparative analysis provides a solid foundation for making informed decisions. This understanding empowers individuals to make choices that align with their objectives, ultimately contributing to a more informed and sustainable approach to welding practices.

6.3 Welding techniques and equipment

Welders already receive training in various welding techniques, which includes understanding the differences in burn-in profiles, strength, and overall quality. Incorporating environmental impacts into this existing training would be beneficial. It is important to note that in the context of a green mentality, prioritizing quality and strength is always a conscious decision. This approach helps minimize waste and reduces the need for additional repair processes. By considering the environmental implications alongside quality and strength, welders can contribute to sustainable practices while ensuring optimal performance and minimizing unnecessary waste.

Moreover, there are various of welding equipment suppliers actively developing new features such as automatic gas reduction systems, pulse functions to enhance welding quality by improving the burn-in profile. However, unless welders are properly trained and educated about these machines, their capabilities, and the potential impact of these new features, may never be realized. Therefore, it is crucial for both VET and the industry to ensure that welders receive the necessary knowledge and awareness to effectively leverage these technological advancements.

6.4 Material usages and reuse materials

When it comes to reusing materials, there is a slight difference in perspective between the industry and VET. From an industry standpoint, the focus lies primarily on production planning to minimize overall scrap rates. In this context, welders may not be directly involved, besides ensuring a high quality to avoid generating any scrap from their process.

On the other hand, VET approaches material reuse from a different perspective. Their goal is to explore ways to prolong the use of materials during training before they need to be scraped. Therefore, VET institutions can put more effort on finding methods to reuse materials for an

extended period. Additionally, incorporating simulators into initial training can be beneficial for VET, as it reduces the need for physical material usage.

While the industry emphasizes minimizing scrap rates through efficient production planning, VET institutions focus on maximizing material utilization throughout training and exploring alternative methods like simulators. These different perspectives cater to the respective needs and objectives of both sectors, promoting sustainable practices.

6.5 Education

From an educational perspective, several other important findings emerged during the research, particularly concerning the adoption of greener practices in education. Two key topics in this regard were simulators and e-learning.

Simulators generated varying opinions among stakeholders. There exists a fine line determining when simulators alone are insufficient for comprehensive education. Currently, the technology is deemed suitable for early-stage training, focusing on welding speed and machine settings. However, real-life welding experience remains essential before entering the job market as a certified welder.

Another significant point is e-learning. E-learning is already widely used, with many students feeling more comfortable using e-books rather than traditional printed materials. Shifting towards electronic platforms presents an opportunity for educational institutions and VET to reduce paper consumption and contribute to a more sustainable approach.

Considering the potential of simulators for specific training aspects and the adoption of e-learning methods, educational institutions and VET can actively incorporate greener practices into their programs. Balancing the advantages of technology-based learning with the necessity of hands-on experience ensures a well-rounded education while minimizing environmental impact.

7. RECOMMENDATIONS

Based on the research and workshops during Work Package 2, several recommendations have been formulated. These recommendations will serve as a vital component in the ongoing efforts and development of the GreenWeld certificate.

Recommendation A

Develop a comprehensive glossary encompassing relevant sustainability and welding training concepts. This glossary will serve as a valuable communication tool, facilitating clear understanding and effective communication within the partnership. Additionally, it will provide added value to the general public, with a specific focus on the target groups, including training centres and the welding industry.

Recommendation B

Develop a set of Competence Units to address sustainability topics within the welding training. These Competence Units could be presented additional units to the existing curriculum. For this propose, the recommendation would be:

- A competence unit for European/International Welding Engineers, offering more detailed and in-depth knowledge.
- A middle competence unit for the European/International Welding Specialist, for the European/International Welding Inspector Comprehensive Level and Standard Level, as well as and for the Comprehensive Level of the Mechanised Welding/Orbital Welding/Robot Welding.
- A competence unit aimed to raise awareness among European/International Welding Practitioner, European/International Welders, Basic level for European/International Welding Inspector, and trainees of the Basic Level of Mechanised Welding/Orbital Welding/Robot Welding course.

Recommendation C

Utilize the ESCO green skills & knowledge collection, to select the skills that are transversal or cross-sectoral in welding filed. This selection will provide a suitable list of skills and knowledge to support when designing the competence units and integrate the green skills in the training with lower impact.

Recommendation D

In the phase of implementation of the Welding Certificates, in WP 4, to incorporate case studies that can adopt ways to reduce or minimize negative environmental impact in welding, for example in the exposure to welding fumes.

Recommendation E

Create a comprehensive training methodology for training organizations. This methodology should include guidelines for Training Organizations' facilities, training procedures and equipment, and training personnel.

Recommendation E.1 - Training Organizations' facilities

- Visible waste collecting areas for recycling and waste sorter raw materials.
- Instruction and requirements of the facility lighting.
- Specific layout for the welding training area, to embrace recycling and reuse of the materials.
- Recycle bin to sorter all kind of waste.

Recommendation E.2 - Training Organizations' training procedures and equipment

- Using e-learning platforms, e-books, Moodle platforms or other digital tools for the theoretical part of the training.
- Include topics about green awareness and green mentality in the theoretical part of the of the training.
- Incorporate welding simulators to the maximum extent possible, while ensuring that the quality of training is not compromised. Additionally, explore the potential of other extended reality (XR) tools or gamification techniques in the future. However, it is crucial to establish a specific limit on the total training hours dedicated to these virtual tools. Simulators should be utilized only in training segments where they do not compromise the quality compared to physical welding machines. Therefore, it may be necessary to define a specific number of practical training hours for the utilization of these virtual tools.
- Incorporate training in different welding machines to ensure green welders are well educated in different machines and thereby able to utilize new features such as automatic gas reduction systems, pulse functions to enhance welding quality by improving the burn-in profile, programs to reduce welding splatters.
- Train different welding techniques to reduce additional post processing.
- Provide education on various gases, focusing on their environmental implications as well as their impact on welding quality. Additionally, emphasize the importance of understanding how to configure machine settings appropriately when using different gases.
- Develop courses tailored to different levels and roles within the welding industry, encompassing positions such as purchasers, management, transportation, and others. These courses aim to raise awareness among individuals in these roles about the environmental impacts of their decisions and actions, ultimately promoting greener practices within the field of welding.

Recommendation E.3 - Training Organizations' training personnel

- The training personnel should possess theoretical knowledge and practical skills in digital technologies, demonstrate proficiency in online training methodologies, and receive training on environmental issues.
- From a practical standpoint, the personnel should hold the green welding certificate, undergo training in the revised Green Welders guidelines, and demonstrate a strong awareness of green practices.

8. ANNEXES

1. Information and data literacy	1.1 Browsing, searching and filtering data, information and digital content:	To articulate information needs, to search for data, information and content in digital environments, to access them and to navigate between them. To create and update personal search strategies.
	1.2 Evaluating data, information and digital content:	To analyse, compare and critically evaluate the credibility and reliability of sources of data, information and digital content. To analyse, interpret and critically evaluate the data, information and digital content.
	1.3 Managing data, information and digital content:	To organise, store and retrieve data, information and content in digital environments. To organise and process them in a structured environment.

2. Communication and collaboration	2.1 Interacting through digital technologies:	To interact through a variety of digital technologies and to understand appropriate digital communication means for a given context.
	2.2 Sharing through digital technologies:	To share data, information and digital content with others through appropriate digital technologies. To act as an intermediary, to know about referencing and attribution practices.
	2.3 Engaging in citizenship through digital technologies:	To participate in society through the use of public and private digital services. To seek opportunities for self-empowerment and for participatory citizenship through appropriate digital technologies.
	2.4 Collaborating through digital technologies:	To use digital tools and technologies for collaborative processes, and for co-construction and co-creation of resources and knowledge.
	2.5 Netiquette:	To be aware of behavioural norms and know-how while using digital technologies and interacting in digital environments. To adapt communication strategies to the specific audience and to be aware of cultural and generational diversity in digital environments.
	2.6 Managing digital identity:	To create and manage one or multiple digital identities, to be able to protect one's own reputation, to deal with the data that one produces through several digital tools, environments and services.

3. Digital content creation	3.1 Developing digital content:	To create and edit digital content in different formats, to express oneself through digital means.
	3.2 Integrating and re-elaborating digital content:	To modify, refine, improve and integrate information and content into an existing body of knowledge to create new, original and relevant content and knowledge.
	3.3 Copyright and licences:	To understand how copyright and licences apply to data, information and digital content.
	3.4 Programming:	To plan and develop a sequence of understandable instructions for a computing system to solve a given problem or perform a specific task.

4. Safety	4.1 Protecting devices:	To protect devices and digital content, and to understand risks and threats in digital environments. To know about safety and security measures and to have due regard to reliability and privacy.
	4.2 Protecting personal data and privacy:	To protect personal data and privacy in digital environments. To understand how to use and share personally identifiable information while being able to protect oneself and others from damages. To understand that digital services use a "Privacy policy" to inform how personal data is used.
	4.3 Protecting health and well-being:	To be able to avoid health-risks and threats to physical and psychological well-being while using digital technologies. To be able to protect oneself and others from possible dangers in digital environments (e.g. cyber bullying). To be aware of digital technologies for social well-being and social inclusion.
	4.4 Protecting the environment:	To be aware of the environmental impact of digital technologies and their use.

5. Problem solving	**5.1 Solving technical problems:**	To identify technical problems when operating devices and using digital environments, and to solve them (from troubleshooting to solving more complex problems).
	5.2 Identifying needs and technological responses:	To assess needs and to identify, evaluate, select and use digital tools and possible technological responses to solve them. To adjust and customise digital environments to personal needs (e.g. accessibility).
	5.3 Creatively using digital technologies:	To use digital tools and technologies to create knowledge and to innovate processes and products. To engage individually and collectively in cognitive processing to understand and resolve conceptual problems and problem situations in digital environments.
	5.4 Identifying digital competence gaps:	To understand where one's own digital competence needs to be improved or updated. To be able to support others with their digital competence development. To seek opportunities for self-development and to keep up-to-date with the digital evolution.