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Project title:

Creating knowLedge and skilLs in AddItive Manufacturing

CLLAIM

Reference number:

2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA

Work Package 4

Work Package Leader EWF

Deliverable 4.1

Qualifications Competence Matrix

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Introduction

Deliverable 4.1 - Qualifications Competence Matrix settles the alignment between CLLAIM Qualifications and European tools.

Project Partners identified the need of its Qualifications being developed with the use of European tools in order to guarantee common understanding and transparency. The CLLAIM guidelines have been developed using the EU tools, namely European Skills, Competences, Qualifications and Occupations taxonomy (ESCO), European Qualifications Framework (EQF), European Credit System for Vocational Education and Training (ECVET), in order to promote and facilitate the introduction of some or all of the CLLAIM guidelines into the national education systems across Europe.

This document provides an overview over the methodologies for the alignment of CLLAIM Qualifications and EU tools, explaining the application of such tools on CLLAIM Guidelines.

One of the aims of this deliverable is also to facilitate the formal recognition of the CLLAIM professional profiles at National level, namely implementing the Qualifications on National Qualification Frameworks (NQF), therefore NQF levels assignment has also been considered.

The main output of this deliverable is the resulting Competence Matrix that summarizes the alignment previously mentioned. This matrix can be used in future developments regarding alignment between AM Qualifications and EU Tools and as a blueprint for future projects European wide.

The document is divided in two chapters including one dedicated to the Qualification Competence Matrix and another to the explanation of each of the methodologies used for alignment with the European Tools ESCO, EQF and ECVET, followed by the explanation of the application of such tools on CLLAIM Guidelines.

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1 – CLLAIM Qualifications Competence Matrix

CLLAIM Qualifications Competence Matrix comprehends the mapping of the core knowledge, skills, autonomy and responsibility descriptors foreseen for each Qualification developed within CLLAIM project, as well as ECVET points allocation for each qualification, their alignment with the European Qualifications Framework (EQF) levels and it´s correspondence with the National Qualifications Frameworks (NQF) levels within the consortium.

The Qualifications Competence Matrix developed in this document will serve as a basis for the formal recognition of CLLAIM Qualifications within National Vocational Education and Training Systems and National Qualifications Framework of consortium Countries and other Countries that in the future integrate the European Harmonized AM Qualification System. The work developed hereinafter will allow the European AM Qualification System to implement its Qualifications at National level, fostering in this way the visibility and effectiveness of the System.

ECVET points have also been allocated to each Competence Unit, based on its specific Workload.

Two Matrixes were developed: one for the Qualifications and one for the Competence Units individually.

Calculation and alignment methods for level assignment and points attribution are thoroughly detailed in chapter 2 of the current document.

To have a clear overlook of the CLLAIM Competence Units please check Annex 5, or even for detailed information please check CLLAIM Guidelines available at http://cllaimprojectam.eu/eureopeanguides.html.

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Qualifications

The following Matrix represents a general description of CLLAIM AM Qualifications and their alignment with EU tools.

QUALIFICATION	KNOWLEDGE	SKILLS	RESPONSIBILITY/AUTONOMY	TEACHING HOURS	WORKLOAD (Hours)	ECVET POINTS	EQF LEVEL	NQF DE	NQF SP	NQF UK[1]
EUROPEAN OPERATOR DED-ARC	Factual and broad concepts in the field of DED–Arc metal additive manufacturing process.	Fundamental cognitive and practical skills required to develop proper solutions and application of procedures and tools on simple and specific of DED–Arc manufacturing problems.	Self-manage of professional activities and simple standard applications of DED–Arc manufacturing in predictable contexts but subject to change.	84	168	6.75	4	4	4	3
EUROPEAN OPERATOR DED-LB	Factual and broad concepts in the field of DED-LB metal additive manufacturing process.	Fundamental cognitive and practical skills required to develop proper solutions and application of procedures and tools on simple and specific of DED-LB manufacturing problems.	Self-manage of professional activities and simple standard applications of DED-LB manufacturing in predictable contexts but subject to change.	84	168	6.75	4	4	4	3
EUROPEAN OPERATOR PBF-LB	Factual and broad concepts in the field of PBF-LB metal additive manufacturing process.	Fundamental cognitive and practical skills required to develop proper solutions and application of procedures and tools on simple and specific of PBF-LB manufacturing problems.	Self-manage of professional activities and simple standard applications of PBF-LB manufacturing in predictable contexts but subject to change.	84	168	6.75	4	4	4	3
EUROPEAN OPERATOR PBF-EB	Factual and broad concepts in the field of PBF-EB metal additive manufacturing process.	Fundamental cognitive and practical skills required to develop proper solutions and application of procedures and tools on simple and specific of PBF-EB manufacturing problems.	Self-manage of professional activities and simple standard applications of PBF-EB manufacturing in predictable contexts but subject to change.	77	144	5.75	4	4	4	3
EUROPEAN METAL AM SUPERVISOR	Factual and broad concepts in the field of Metal additive manufacturing processes.	Fundamental cognitive and practical skills required to develop proper solutions and application of procedures and tools on simple and specific of Metal additive manufacturing problems.	Self-manage of professional activities and simple standard applications of Metal AM manufacturing in predictable contexts but subject to change. Take responsibility for supervising routine metal AM production and related personnel.	91	182	7.25	4	4	4	3

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QUALIFICATION	KNOWLEDGE	SKILLS	RESPONSIBILITY/AUTONOMY	TEACHING HOURS	WORKLOAD (Hours)	ECVET POINTS	EQF LEVEL	NQF DE	NQF SP	NQF UK[1]
EUROPEAN METAL AM INSPECTOR	Factual and broad concepts of the principles, applicability and potential defects of metal AM processes; the principles and applicability of various inspection techniques; the applicable regulations and standards applied to AM.	Fundamental cognitive and practical skills required to implement proper solutions and application of Metal AM inspection procedures.	Self-manage of professional activities and simple standard applications of Metal AM inspection activities in predictable contexts.	129.5	259	10.25	4	4	4	3
EUROPEAN METAL AM DESIGNER FOR DED PROCESSES	Advanced knowledge and critical understanding of the theory, principles and applicability of metal additive manufacturing design for DED processes.	Advanced problem-solving skills including critical evaluation and design thinking, allowing to choose the proper technical and economical solutions, when designing for DED metal additive manufacturing processes, in complex and unpredictable conditions.	Manage the selection of metal additive manufacturing processes in a highly complex context. Act autonomously in decision making and of the metal additive manufacturing personnel's tasks.	119	238	9.5	6	6	6	6
EUROPEAN METAL AM DESIGNER FOR PBF PROCESSES	Advanced knowledge and critical understanding of the theory, principles and applicability of metal additive manufacturing design for PBF processes.	Advanced problem-solving skills including critical evaluation and design thinking, allowing to choose the proper technical and economical solutions, when designing for PBF metal additive manufacturing processes, in complex and unpredictable conditions.	Manage complex PBF processes design projects, taking responsibility for decision making in unpredictable PBF processes design applications.	112	224	9	6	6	6	6

[1] https://ec.europa.eu/ploteus/en/compare; https://www.cedefop.europa.eu/files/spain_-_european_inventory_on_nqf_2016.pdf

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Competence Units

Hereinafter all CLLAIM Competence Units are listed in a table identifying their respective Teaching Hours, Workload, ECVET points and EQF Levels. To check the full name of the Competence Units please check annex 5.

Furthermore, to have a detailed overview of how the ECVET points and EQF levels are determined, please check the following chapters dedicated to that specific European tool.

COMPETENCE UNIT	QUALIFICATION	TEACHING HOURS	WORKLOAD (Hours)	ECVET POINTS*	EQF LEVEL[1]
CU 00	All	7	14	O.5	4
CU 01	Metal AM Operator DED-arc; Metal AM Supervisor; Metal AM Inspector	14	28	1	4
CU 02	Metal AM Operator DED-arc	11	22	1	4
CU 03	Metal AM Operator DED-arc	7	14	0.5	4
CU 04	Metal AM Operator DED-arc	21	42	1.75	4
CU 05	Metal AM Operator DED-arc	7	14	0.5	4
CU 06	Metal AM Operator DED-arc	7	14	0.5	4
CU 07	Metal AM Operator DED-arc	14	28	1	4
CU 08	Metal AM Operator DED- LB	21	42	1.75	4
CU 09	Metal AM Operator DED-LB	14	28	1	4
CU 10	Metal AM Operator DED- LB	7	14	0.5	4
CU 11	Metal AM Operator DED- LB	21	42	1.75	4
CU 12	Metal AM Operator DED- LB	7	14	0.5	4
CU 13	Metal AM Operator DED- LB	7	14	0.5	4
CU 14	Metal AM Operator DED-arc	14	28	1	4
CU 15	Metal AM Operator PBF- LB; Metal AM Supervisor; Metal AM Inspector	14	28	1	4
CU 16	Metal AM Operator PBF- LB	7	14	0.5	4
CU 17	Metal AM Operator PBF- LB	3.5	7	0.25	4
CU 18	Metal AM Operator PBF- LB	14	28	1	4
CU 19	Metal AM Operator PBF- LB	3.5	7	0.25	4

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COMPETENCE UNIT	QUALIFICATION	TEACHING HOURS	WORKLOAD (Hours)	ECVET POINTS*	EQF LEVEL[1]
CU 20	Metal AM Operator PBF-LB	7	14	0.5	4
CU 21	Metal AM Operator PBF-LB	7	14	0.5	4
CU 22	Metal AM Operator PBF-EB; Metal AM Inspector	14	28	1	4
CU 23	Metal AM Operator PBF-EB	7	14	1	4
CU 24	Metal AM Operator PBF-EB	3.5	7	1	4
CU 25	Metal AM Designer for DED Processes	14	28	1	6
CU 46	Metal AM Operator PBF-EB; Metal AM Operator PBF-LB; Metal AM Supervisor	14	28	1	4
CU 47	Metal AM Operator PBF-EB; Metal AM Operator PBF-LB; Metal AM Supervisor	14	28	1	4
CU 48	Metal AM Operator PBF-EB; Metal AM Operator PBF-LB; Metal AM Supervisor	14	28	1	4
CU 49	Metal AM Operator PBF-LB	7	14	0.5	4
CU 50	Metal AM Operator PBF-EB	14	28	1	4
CU 51	Metal AM Operator PBF-EB	3.5	7	0.25	4
CU 52	Metal AM Operator PBF-EB	7	14	0.5	4
CU 53	Metal AM Operator PBF-EB	7	14	0.5	4
CU 57	Metal AM Designer for DED Processes;	21	42	1.75	6
CU 58	Metal AM Designer for DED Processes;	35	70	2.75	6
CU 59	Metal AM Designer for PBF Processes;	21	42	1.75	6
CU 60	Metal AM Designer for PBF Processes;	28	56	2.25	6
CU 61	Metal AM Designer for DED Processes; Metal AM Designer for PBF Processes	21	42	1.75	6
CU 62	Metal AM Inspector	21	42	1.75	4
CU 63	Metal AM Inspector	28	56	2.25	4
CU 64	Metal AM Inspector	38.5	77	3	4

[1] These values can be adapted at National Level

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2 – CLLAIM Qualifications and EU Tools

Alignment with the European Qualifications Framework - EQF

The European Qualifications Framework (EQF) is a common European reference framework whose purpose is to make qualifications more readable and understandable across different countries and systems. Covering all levels of qualifications and in all sub-systems of education and training, EQF provides a comprehensive overview over qualifications in the 39 European countries currently involved in its implementation.

The EQF is described as a translation tool that helps understand and compare qualifications awarded in different countries and by different education and training systems. It acts as a bridge between National Qualification Systems, enabling their comparison.

The core of the EQF is its eight reference levels descriptors defined in terms of learning outcomes, i.e. knowledge, skills and autonomy-responsibility. Learning outcomes express what individuals know, understand and are able to do at the end of a learning process. Furthermore, to cope with this framework Countries developed National Qualifications Frameworks (NQFs) that serve as a comparison between the EQF levels and National Qualifications levels.

Below it may be found EQF framework that defines the Qualification Levels descriptors in terms of Learning Outcomes.[1]

Table 1 European Qualification Framework

EQF Level	Knowledge	Skills	Responsibility and autonomy
	In the context of EQF, knowledge is described as theoretical and/or factual.	**In the context of EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).**	**In the context of the EQF responsibility and autonomy is described as the ability of the learner to apply knowledge and skills autonomously and with responsibility**
Level 1	Basic general knowledge	Basic skills required to carry out simple tasks	Work or study under direct supervision in a structured context
Level 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
Level 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	Take responsibility for completion of tasks in work or study; adapt own behavior to circumstances in solving problems

[1] https://www.cedefop.europa.eu/pt/events-and-projects/projects/european-qualifications-framework-eqf

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		applying basic methods, tools, materials and information	
Level 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
Level 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
Level 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
Level 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
Level 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[2]

[2] https://ec.europa.eu/ploteus/pt/node/1440

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During the implementation of CLLAIM project the Qualifications developed followed EWF methodology for design of Qualifications (developed under the scope of ERASMUS + project RAINBOW).

EWF´s methodological approach to the design of Qualifications is strongly based on industrial needs and implies the use of a common terminology applicable to all its Qualifications. It is developed on a modular basis where each Qualification comprehends a set of Competence Units, organized in Learning Outcomes.

The EWF System assures harmonised knowledge, skills and competence for any holder of a diploma in any region of the world, and comprises Education, Examination and Qualification Guidelines for different professional/proficiency levels.

For that purpose, EWF System has its own reference framework, containing seven different proficiency levels, currently organized in statements of general descriptors defined in terms of knowledge, skills, autonomy and responsibility for each proficiency level that its qualifications encompass, as described in Table 2.

The EWF Training and Qualification system success is supported by a robust and transparent quality assurance system, which is developed, implemented and recognised by the complete chain of individuals and organizations involved, from training institutions, national certification bodies, companies, trainers and trainees.

Taking advantage from EWF existing framework for Additive Manufacturing, the assignment of proficiency levels within CLLAIM developed Qualifications is fully aligned both with EWF framework and the EQF level descriptors.

The following table illustrates the framework used in CLLAIM project.

Table 2 Sectoral Qualification Framework - Additive Manufacturing

AM PROFILE	EQF LEVEL	CLLAIM LEVEL	KNOWLEDGE	SKILLS	AUTONOMY AND RESPONSIBILITY
	7	EXPERT	Highly specialised and forefront knowledge including original thinking, research and critical assessment of theory, principles and applicability of metal additive	Highly specialised problem- solving skills including critical and original evaluation, allowing to define or develop the best technical and economical solutions, when applying metal additive	Manage and transform the metal additive manufacturing processes in a highly complex context. Fully responsible for the definition and revision of personnel's tasks.

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					manufacturing processes.	manufacturing processes, in complex and unpredictable conditions	
DESIGNERS			6	ADVANCED	Advanced knowledge and critical understanding of the theory, principles and applicability of metal additive manufacturing processes.	Advanced problem-solving skills including critical evaluation, allowing to choose the proper technical and economical solutions, when applying metal additive manufacturing processes, in complex and unpredictable conditions	Manage the applications of metal additive manufacturing processes in a highly complex context. Act autonomously in decision making and definition in the definition of the metal additive manufacturing personnel's tasks.
			5	SPECIALIZED	Specialised, factual and theoretical of theory, principles and applicability of metal additive manufacturing processes	Specialised range of cognitive and practical skills, allowing to develop solutions or choose the appropriate methods, when applying metal additive manufacturing processes in common/regular problems.	Manage and supervise common or standard metal additive manufacturing processes, in an unpredictable context. Take responsibility in standard work and supervise the metal additive manufacturing personnel's tasks.
OPERATORS	INSPECTORS	SUPERVISORS	4	INDEPENDENT	Factual and broad concepts in the field of metal additive manufacturing processes.	Fundamental cognitive and practical skills required to develop proper solutions and application of procedures and tools on simple	Self-manage of professional activities and simple standard applications of metal additive manufacturing processes in

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						and specific metal additive manufacturing problems.	predictable contexts but subject to change. Supervise routine tasks and similar function workers, as well as take responsibility for decision making in basic work.

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Alignment with National Qualification Frameworks - NQF

National qualifications frameworks (NQFs) classify qualifications by level, based on learning outcomes. This classification reflects the content and profile of qualifications - that is, what the holder of a certificate or diploma is expected to know, understand, and be able to do. The learning outcomes approach also ensures that education and training sub-systems are open to one another. Thus, it allows people to move more easily between education and training institutions and sectors.[3]

In a nutshell, the NQF allows a comparison with EQF levels in each country that has this framework implemented. In CLLAIM project an approach was implemented to achieve the formal recognition of CLLAIM Qualifications at National level was implemented.

CLLAIM project aims at creating a European Qualification System in Additive Manufacturing. One of the drivers to achieve a European Harmonization of the System is to introduce the qualifications developed under CLLAIM project in the National VET Systems. The alignment between EQF and the sectoral AM sectoral framework used in CLLAIM EWF Proficiency levels (explained previously) allows a better possible alignment between CLLAIM Qualifications and National Qualifications Framework.

CLLAIM Partners will foster the implementation of CLLAIM project into the National Educational Systems. A methodology for this implementation was developed and agreed within CLLAIM consortium. The methodology expects partners to initiate contact with National Qualifications Agencies and conduct meetings with the Agencies from their own Countries in order to further implement the process that leads to implementation at National Level.

[3] https://www.cedefop.europa.eu/en/events-and-projects/projects/national-qualifications-framework-nqf

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Methodology for the recognition of CLLAIM Qualifications at National Level

The alignment between CLLAIM Qualifications and European tools facilitates this process. During project implementation CLLAIM partners used a Methodology support the recognition of European Qualifications into the National Educational Systems developed prior to the project (RAINBOW project http://project-rainbow.eu/index.html).

The methodology implemented during CLLAIM, is a significant step towards recognition of Qualifications European wide at National Level. This methodology, explained during the next chapters, was developed for all European countries and not only for the consortium member countries. Moreover, the methodology can also be benchmark to other Sectoral Qualification Frameworks besides Additive Manufacturing.

Hereinafter will be briefly explained the methodology used. To see more detailed information please check annex 1.

The approach used for the recognition process of CLLAIM Qualifications at National level is divided into four recommendations. By keeping these recommendations, the success of the approach to implement CLLAIM Qualifications at National Level is assured.

Recommendation 1: Establishment of a Sectoral Qualification Framework

As previously explained, CLLAIM Qualifications were developed under a methodology based on Learning Outcomes approach. The profiles were given a Proficiency Level that references a direct correspondence to EQF levels.

This way the establishment of a Sectoral Qualification Framework for the Additive Manufacturing sector is ensured, and therefore an alignment between CLLAIM Qualifications and the European Qualification Framework is made.

Recommendation 2: Inclusion of Technical European Qualifications/Modules as part of a National Qualification

The recommendation is that all European National Qualification Agencies from the Member States (National Authority for Education) decide on the structure of their qualifications in such a way to allow the easy integration/adoption of different International Qualifications/Modules/Competence Units, based on the proposed Proficiency Levels.

The procedure passes through adding to the National Qualifications (composed by several national requirements), technological content of the European Professional Qualifications.

The procedures may vary from one country to another.

Recommendation 3: Assure Mechanisms for Quality Assurance and Transparency

To ensure the process runs smoothly the compliance with a Quality Assurance System is necessary. The European Harmonized Qualification System developed in CLLAIM is based on a Quality Assurance system defined on Deliverables 1.2 and 1.3, *Strategic Plan* and *European Additive Manufacturing Qualification System's Toolkit* respectively.

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The Quality Assurance System adopted in CLLAIM includes operational procedures defining the quality assurance requirements for the design, implementation and harmonised assessment. Operational procedures comply with ISO 17024 (Conformity assessment -- General requirements for bodies operating certification of persons). Furthermore, the training within the harmonized system is given by Authorised Training Bodies (ATBs), under Authorised Nominated Bodies (ANBs) supervision, which combine both supporting knowledge and application experience, in a close relation with industry and their needs.

This way the mechanisms for Quality Assurance and Transparency are assured.

Recommendation 4: Guarantee Continuous Update and Involvement of Stakeholders

In addition to the Quality Assurance System, a continuous improvement of the Qualifications and Competence Units and involvement of the stakeholders is crucial.

Accordingly, to the AM Qualification System's objectives, the competence units developed during CLLAIM are constantly updated in order to keep up with industry high standards in this field.

Moreover, the involvement of stakeholders from both the education/training system and the sector/industry/ economical fields is also of extreme importance to guarantee the successful recognition of the AM qualifications at national and European level. The role of each stakeholders could be:

- Independent VET providers/ATBs/Universities
- Awarding bodies/ANBs
- Companies (SMEs, medium and large) from the Additive Manufacturing sector/industry

Guide for conducting meetings with National Qualification Agencies

In order to take full advantage of the Qualifications Matrix presented previously it is important to foster the contact with National Qualification Authorities. Therefore, besides adopting the methodology described above, CLLAIM partners also developed a guide to conduct possible meetings with National Qualification Agencies. The developed guide goes as follows:

Agenda topics (proposal)

- CLLAIM Project objectives and results
- Added value for students; training centres and National Qualification System [replace by the correspondent country name/system]
- AM Operator – a new Professional Profile
- Sectoral approach for the uptake/alignment of European AM Qualifications /parts of the qualifications in the National VET System/ National Qualifications Framework
- Challenges and solutions
- Wrap up and next actions

Script

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- **CLLAIM Project objectives and results**

1. Overview on CLLAIM project (Goals/objectives/results) - Creation of AM Qualifications /European System

- **Added value**

2. Approach/explain AM Technology (Facts & Figures of the technology)

3. Explain the added value of having AM Qualifications into the student's curriculum and as national Qualification / relevance at EU and National Level;

Examples:

Having Qualifications at National level that are strictly aligned with industry needs;

Having Qualifications for a growing industry at its early days, recognized European wide;

Having Qualifications that avoid the duplication of contents;

Possibility to ensure harmonisation of the technical content at the European level and still give flexibility to the different National Qualification Agencies in adding content and aligning the qualification to their national requirements

- **AM Operator - new Professional Profile** (State also the 4 Qualifications to be created, but focus on this one)
  - Professional profile description
  - Relevance of the Profile (industrial need)
  - Explain structure of the course (CUs- modular system) + workload
  - Explain that LOS terminology is used, which facilitates the alignment with NQF /EQF
  - Present Sectoral Proficiency level: **4 - Independent** (= EQF level 4) - state that this level was defined with the Involvement of sectoral stakeholders with expertise in technology /process and is aligned with industry requirements

- **Sectoral approach for national recognition**

4. Explain the approach for including the AM European qualification (parts of the qualification) in the National Qualification System (See PowerPoint CLLAIM_National Agencies Approach for better understanding of this topic)

5. National Qualifications are divided in Technology Requirements (AM Competence Units) and National Requirements (e.g. Mathematics, Physics, Languages, etc.). What we are proposing to be included is the technological part of the National Qualification and then to add the National Requirements.

6. Explain approach in the PowerPoint document (CLLAIM_National Agencies Approach) and highlight the alignment between AM Qualifications with EU policies such as EQF.

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- **Challenges and solutions**

7. Discuss about possible barriers to uptake regarding each country (e.g. Reference to different EQF levels of the same European qualifications; Adversities in inclusion of European qualifications as part of a module/national qualification; Establish quality assurance and transparency mechanisms; Self-declared reference to EQF of international qualifications; etc.)

The focus should be to try to list/identify specific constraints at national level; and to negotiate a solution for the formal recognition.
Try to identify the receptivity of the Agency for the AM Operator Qualification and remaining AM Qualifications foreseen in the Project.

8. Define the next actions to support the alignment process (integration) for these qualifications at national level = formal recognition of the AM Qualifications and competence units. (See PowerPoint CLLAIM_National Agencies Approach and RAINBOW Project Summary for further details)

- Establishment of a Sectoral Qualification Framework (explain that this was done in the project in order to easily implement the Qualifications at a National level)
- Inclusion of Technical International Qualifications/Modules as part of a National Qualification
- Assure Mechanisms for Quality Assurance and Transparency
- Guarantee Continuous Update and Involvement of Stakeholders

Supporting documents

- Project Flyer
- Agenda
- Attendance list
- Presentation (Optional)
- Minutes / To-do-list
- Rainbow Project Summary (Optional)
- CLLAIM Guidelines

Contact with National Qualification Agencies

CLLAIM partners applied the approach strategy here defined in their countries and obtained different responses from the National Qualification Agencies in each consortium country (ES, UK, DE).

The feedback is described below:

Germany

In Germany the response to the approach for recognition of CLLAIM Qualifications at National level was negative, due to CLLAIM Qualifications not being a formal Qualification in Germany. The response from the German Qualifications Agency was as follows. (To have a full overview of the all responses please see annex 2).

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In Germany, only formal qualifications i.e. qualifications that are regulated by federal or state law, can be assigned to the DQR so far. Unfortunately, there is still no procedure for assigning non-formal qualifications, i.e. qualifications that are not regulated by the state administration, so that it is not yet possible to assign non-formal qualifications. The reason for this is that no consensus on criteria and a possible procedure has yet been reached in the responsible DQR committees.

United Kingdom

In the UK the response from the National Qualification Agency was positive, although there are some challenges that need to be overcome. In order to set CLLAIM Qualifications as part of UK National Qualification Framework the following approaches must be put to practice.

1) The qualifications can be promoted to Industry committees which is already the aim of the project and its sustainability. Recognition of the qualification by industry is often a slow process but making the qualification/certification available is the first step.
2) Additionally, the UK currently promotes an apprenticeship scheme and each scheme can be mapped out to the apprenticeship standard which then attracts funding through the government ESFA (Education and Skills Funding Agency) once approved.

Project partners consider that the process of delivering the standard can be much labored and is currently taking up to 5 years to process through the government agency. However, partners believe that a combination of 1) and 2) would be a beneficial way to proceed. (To have a full overview of the all response please see annex 3).

Spain

In Spain the main problem is the fact that there is not a centralized Education System. This means that for each region the Educational System behaves differently. Despite that, CLLAIM partners established contact with Spanish National Qualification Agency in order to try achieving the results expected in CLLAIM.

Spain has two distinct National Qualification Frameworks, namely MECU and MECES. Although there is a relationship between Spanish qualifications and the EQF. For years, attempts have been made to implement the system of EQF levels within the national qualifications framework in Spain. However, the education system, which is not entirely centralized in Spain due to the existence of autonomies, does not take this relationship into account in practice. Therefore, CLLAIM qualifications have been aligned but cannot be implemented.

CESOL contacted the Director of the Vocational Training Unit of SEPIE (Spanish Service for the Internationalization of Education), explaining the content and development of the CLLAIM project and the needs required, recognizing the profiles of Operator, Supervisor, Designer and Inspector within the national framework of qualifications in Spain.

CESOL was informed that the situation was at a standstill and it would not be possible to implement the 4 levels within the national qualifications framework due to the fact that in each Spanish Autonomous Community a series of freedoms are granted and among them is the level of education. Over time, it was tried again by telephone and the consortium was told that such a process of introducing qualifications into the country was not viable. Being so, CLLAIM developed the procedures so that once this situation is possible adjustments are made in order

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to introduce CLLAIM Qualifications in Spain National Qualification Frameworks. (To have a full overview of the all response please see annex 4)

Overall Commitment of CLLAIM Consortium

Despite the answers received from the contacts made, CLLAIM partners aim to continue the engagement with National Qualification Authorities in consortium countries to a Conference and Meeting (D6.5 Cluster Meeting) so that the recognition process of the European AM Qualifications at national level is boosted. This meeting will occur in alignment with the either European Final Conference or one of the project's Mid Term Conference.

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Feeding ESCO Pillars

ESCO is an initiative that supports Europe 2020 and Skills agenda for Europe. *European Skills, Competences, Qualifications and Occupations* (ESCO) is the European multilingual classification of Skills, Competences, Qualifications and Occupations. ESCO works like a dictionary, describing, identifying and classifying professional occupations, skills, and qualifications relevant for the EU labour market and education and training. The ESCO skills are available in 27 languages, through the classification of these skills the European labour market becomes more effective and integrated and enables a better communication between the worlds of work and education/training. The ESCO taxonomy is constructed under these 3 pillars: occupations, skills/competences and qualifications.[4]

CLLAIM project aims to transfer the developments in terms of AM profiles to feed two ESCO pillars: occupations and skills/competences. Therefore, all the Guidelines developed under the project scope were done in accordance with ESCO taxonomy.

Through the SAM project/Bueprint the information on AM profiles was reported to the ESCO Team, using the appropriate template:

Table 3 ESCO Portal Report template

Scope	Information on regulated profession	Essential skills	Essential knowledge	Optional skills	Optional knowledge
Clarify the boundaries of this occupation and what distinguish it from existing profiles	Is this occupation regulated at national level?	Provide a list of essential skills/competences that are needed to perform this occupation	Provide a list of essential knowledge/know-how needed to perform this occupation	Provide a list of optional skills and competences that can be required in specific working environments	Provide a list of optional knowledges

On the following sections it is illustrated the information that was provided to the ESCO portal.

[4] https://ec.europa.eu/social/main.jsp?catId=1326&langId=en

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Metal AM Operator Profiles

Table 4 ESCO portal report of Metal AM Operator Profiles

Scope	Information on regulated profession	Essential skills	Essential knowledge	Optional skills	Optional knowledge
Clarify the boundaries of this occupation and what distinguish it from existing profiles	Is this occupation regulated at national level?	Provide a list of essential skills/competences that are needed to perform this occupation	Provide a list of essential knowledge/know-how needed to perform this occupation	Provide a list of optional skills and competences that can be required in specific working environments	Provide a list of optional knowledges
Metal additive manufacturing (Metal AM) Operators: operate machines using Metal AM processes, including, fitting and setting up, maintenance and repair. Metal AM Operators have factual and broad concepts in the field of metal additive manufacturing process. They are able to develop solutions on basic and specific problems related with Metal AM machines and processes and self-manage the handling of feedstock (approval, storage, contamination, traceability).	n.a	Fit and set-up the Metal AM systems Prepare build platform and feedstock Perform file loading Verify parameters specifications Follow HSE procedures Follow QA procedures Prepare parts for post processing	Metal AM processes principles, Metal AM hardware and software systems, build cycle operations, Machine functionalities and monitoring systems, HSE procedures, Consumables, feedstock and substrate	Manage powders for Metal AM	Powder handling, storage and reconditioning

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Metal AM Designers

Table 5 ESCO portal report of Metal AM Designer Profiles

Scope	Information on regulated profession	Essential skills	Essential knowledge	Optional skills	Optional knowledge
Clarify the boundaries of this occupation and what distinguish it from existing profiles	Is this occupation regulated at national level?	Provide a list of essential skills/competences that are needed to perform this occupation	Provide a list of essential knowledge/know-how needed to perform this occupation	Provide a list of optional skills and competences that can be required in specific working environments	Provide a list of optional knowledges
Metal additive manufacturing (AM) Designers : design Metal AM solutions for AM Processes ensuring and validating that parts can be made cost-effective and efficiently. They also close design projects by verifying requirements for production with engineers as well as process requirements, ensuring liaison with other technical areas to sign of drawings, contributing to projects in a teaming environment cooperation with AM Team. Metal AM Designers have advanced knowledge and critical understanding of the theory,	N.A	Design and redesign Metal AM parts Interpret parts requirements Assess Costs in Design Close design project Analyse simulation results Evaluate Topology Optimization (TO) Interpret finite element (FE) simulation results Document technical conclusions deriving from simulation results	Capabilities and limitations of Metal AM processes influence in design Design considerations required for Metal AM parts design Post processing influences in design Influence of parts requirements in design; Design optimisation. Topology Optimization Stress and Strain Analysis Phase transformations	Execute/perform Topology Optimization Create finite simulation models (FEM) Debug modelling optimization	Validation and Calibration strategies Application of the relevant Material properties, Boundary conditions and mesh characteristics

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principles and applicability of metal additive manufacturing design for Metal AM processes. They are able to manage complex Metal AM processes design projects, taking responsibility for decision-making in design applications.					

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Metal AM Supervisors

Table 6 ESCO portal report of Metal AM Supervisor Profile

Scope	Information on regulated profession	Essential skills	Essential knowledge	Optional skills	Optional knowledge
Clarify the boundaries of this occupation and what distinguish it from existing profiles	Is this occupation regulated at national level?	Provide a list of essential skills/competences that are needed to perform this occupation	Provide a list of essential knowledge/know-how needed to perform this occupation	Provide a list of optional skills and competences that can be required in specific working environments	Provide a list of optional knowledges
Metal AM Supervisors: implement Quality, Health & Safety Environment procedures at the shop floor including recording the essential information during the AM manufacturing process. They have factual knowledge in the field of Metal additive manufacturing processes, quality health and safety assurance in shop floor. They are able to develop proper solutions and application of procedures and tools related with quality, health and safety on shop floor while also taking responsibility for supervising routine metal AM	N.A	Ensure the implementation of QA/QC procedures and instructions (e.g. feedstock storage and handling); Monitor the compliance of the AM production process and the AM parts with the relevant documents (e.g. standards, product specifications, legislation); Implement preventive actions to avoid defects; Implement corrective actions to eliminate defects; Provide guidance to AM operators in the day-to-day activities; Assign tasks to AM operators based on job requirements. Ensure compliance with HSE requirements and instructions featuring Metal AM processes and systems; Provide support to management and	Metal AM processes principles Quality Assurance and Quality Control HSE in facilities HSE for different energy sources HSE for different types of feedstock Powder handling, storage and reconditioning	N.A	N.A

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production, machines and related personnel.		operational teams in all aspects of safety, health, and environmental issues; Implemente corrective actions to avoid hazardous risks. Manage powders for Metal AM			

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Metal AM Inspectors

Table 7 ESCO portal report of Metal AM Operator Profiles

Scope	Information on regulated profession	Essential skills	Essential knowledge	Optional skills	Optional knowledge
Clarify the boundaries of this occupation and what distinguish it from existing profiles	Is this occupation regulated at national level?	Provide a list of essential skills/competences that are needed to perform this occupation	Provide a list of essential knowledge/know-how needed to perform this occupation	Provide a list of optional skills and competences that can be required in specific working environments	Provide a list of optional knowledges
Metal additive manufacturing (AM) Inspectors perform inspections to Metal Additive Manufacturing parts production and equipment ensuring adequate and controlled use. They also carry out quality assessments of the AM process at various critical stages and conduct visual inspection to identify and evaluate imperfections in Metal AM parts and assess against agreed acceptance criteria. Metal AM Inspectors have factual and broad knowledge of the principles, applicability and potential defects of metal AM processes, the principles and	N.A	Apply Quality Assurance /Quality Control checks. Verify if plant facilities and equipment are adequate to parts production Verify if parts production is in compliance with applicable standards/codes Identify non-conformities related with all AM production value chain Verify the adequacy of qualification records of staff engaged in the AM process. Perform Metal AM production inspections Verify the requirements of inspection equipment and its suitability for the testing requirements of the AM part Verify records of equipment and test procedures used for metallurgical and	Metal AM processes principles Quality Assurance and Quality Control principles in Metal AM production Machine and Parts Qualification Standards applied to Metal AM production Metal AM personnel role and activities Measurement, inspection and control during Metal AM production Inspection and testing plans; Characterization and evaluation of Metal AM manufacturing imperfections; Destructive Testing (DT) and Non-destructive testing (NDT) tests characteristics, application and type of delivered information; Typical quality control and quality assurance	N.A	N.A

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applicability of various inspection techniques and the applicable regulations and standards applied to AM. They are able to self-manage the implementation of proper solutions and application of Metal AM inspection procedures, being responsible for verifying all Metal AM related activities in production and compile the final inspection document package.		mechanical testing in the AM process. Select appropriate test procedures for the inspection activities carried out during and after the AM process, Carry out audits of AM build materials supply and storage to be used for the AM part manufacture Verify if the manufacturing process is in compliance with the applicable standards Sign off final Inspection documents package per AM part/s	documentation used in Metal AM inspection		

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Alignment with ECVET

In this chapter a brief overview of the ECVET points Methodology will be given and how it will be applied to the European Qualifications developed under the scope of CLLAIM project.

The European Credit System for Vocational Education and Training (ECVET) is a common methodological framework to facilitate the recognition of learning, transfer of learning credits from one qualification system to another and promotes transnational mobility and access to lifelong learning for learners and workers. ECVET brings a range of benefits to all those involved in geographical mobility and lifelong learning. In terms of mobility, ECVET works hand in hand with the European Qualifications Framework (EQF) to provide greater transparency in European qualifications, promoting the mobility of workers and trainees, and facilitating lifelong learning. This Methodology brings together a wide range of actors, at local, national and European levels, with a view to encourage its wider implementation and use, particularly in learning mobility. ECVET is focused on technical components that, together, facilitate the process of learning recognition, irrespective of the country or education system in which the learning took place. For implementing ECVET with success, it requires that the Qualifications are described in terms of Learning Outcomes brought together in units, and units often accumulated to form the basis of qualifications or awards (this is the exact methodology applied on CLLAIM project). Assessment, validation and recognition processes must also be agreed among all those participating, and should respect existing national, regional, sectoral or institutional practice. The development of CLLAIM guideline is in accordance with the Recommendation of the European Parliament and Of the Council of 18 June 2009 on the establishment of a European Credit System for Vocational Education and Training (ECVET).

Concerning the ECVET points, these are a numerical representation of the overall weight of learning outcomes in a qualification and of the relative weight of units in relation to the qualification. Together with units, descriptions of learning outcomes and information about the level of qualifications, ECVET points support the understanding of a qualification. The number of ECVET points allocated to a qualification, together with other specifications, can indicate for example, that the scope of the qualification is narrow or broad. The number of ECVET points allocated to a unit provides the trainees with information concerning the relative weight of what s/he has accumulated already. It also provides the learner with information concerning what remains to be achieved. It is important to say that ECVET points and credits are two different things. While credits designate the learning outcomes the learner has already achieved successfully, ECVET points provide information about the qualification and the units. A credit is related to a person and his/her personal achievement; ECVET points are linked to the qualification structure and description. In the scope of the EWF Qualifications according ECVET, it is important to explain how the ECVET points were allocated to all CLLAIM Qualifications. In this sense, the relational used for the definition of teaching hours, workload and ECVET points was the following:

- Teaching hours: refer to the minimum hours of face to face training defined in the CLLAIM Guidelines;
- Workload: calculated based on the assumption that each teaching hour will presuppose an additional effort of about the double time of self-learning, meaning 1 teaching hour will correspond to 2 hours of workload;

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- ECVET points: allocation was done considering that 1 credit is attributed for an estimated 25 hours workload. The rounding rules applied to the credit system was to round up to the closest quarter unit, as follows: [0,25]; [0,50]; [0,75]; [0,00].

To have a clear overview of the implementation of ECVET points please check the chapters related to CLLAIM Qualifications Matrix and Competence Units Matrix.

Furthermore, to illustrate the attribution of ECVET points to a Qualification and Competence Unit the following example was conducted:

Qualification - European Operator DED-arc (84 teaching hours)

Workload = 84 * 2 = 168h

ECVET points = 168 / 25 = 6.72 = 6.75 points

Competence Unit - CU 00 Additive Manufacturing Processes Overview (7 teaching hours)

Workload = 7 * 2 = 14h

ECVET points = 14 / 25 = 0.56 = 0.5 ECVET points

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3 – Annexes

Annex 1 – Qualifications implementation at National Level

CLLAIM_National Agencies Approach_

RainBow Project Summary.pdf

Annex 2 – German National Qualification Agency Response

CLLAIM-WP4-Response German Nationa

Annex 3 – United Kingdom National Qualification Agency Response

CLLAIM_WP4_Response UK National Qua

Annex 4 – Spain National Qualification Agency Response

CLLAIM_WP4_Response ES National Qua

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Annex 5 – CLLAIM Competence Units List

	Designation
CU 00	Additive manufacturing Process Overview
CU 01	DED-Arc Process
CU 02	Quality Assurance (QA) in DED-Arc
CU 03	Health, Safety and Environment (HSE) in DED-Arc
CU 04	Fit and set-up of DED-Arc systems
CU 05	Manufacturing of DED-Arc parts
CU 06	Post processing of DED-Arc parts
CU 07	Maintenance of DED-Arc systems
CU 08	DED-LB Process
CU 09	Quality Assurance (QA) in DED-LB
CU 10	Health, Safety and Environment (HSE) in DED-LB
CU 11	Fit and set-up of DED-LB systems
CU 12	Manufacturing of DED-LB parts
CU 13	Post processing of DED-LB parts
CU 14	Maintenance of DED-LB systems
CU 15	PBF-LB Process
CU 16	Quality Assurance (QA) in PBF-LB
CU 17	Health, Safety and Environment (HSE) in PBF-LB
CU 18	Hardware, software and build file set-up for PBF-LB
CU 19	Monitoring and managing the manufacturing of PBF-LB parts
CU 20	Post-processing of PBF-LB parts
CU 21	Maintenance of PBF-LB systems
CU 22	PBF-EB Process
CU 23	Quality Assurance (QA) in PBF-EB
CU 24	Health, Safety and Environment (HSE) in PBF-EB
CU 25	Post Processing
CU 46	Quality Assurance for Metal AM Processes
CU 47	HSE for Metal AM Processes
CU 48	Powder Handling
CU 49	Laser Beam Characterisation
CU 50	Hardware, software and build file set-up for PBF-EB
CU 51	Monitoring and managing the manufacturing of PBF-EB parts
CU 52	Post-processing of PBF-EB parts
CU 53	Maintenance of PBF-EB systems
CU 57	Relevant principles of DED Processes for Design
CU 58	Design Metal AM parts for DED Processes
CU 59	Relevant principles of PBF Processes for Design
CU 60	Design Metal AM parts for PBF Processes
CU 61	Simulation Analysis
CU 62	Simulation Execution
CU 63	Quality Assurance for Inspection
CU 64	Inspection-Examination and Testing

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