

D2.4 - Mapping of European validation models

Work package 2 – Task 2.6 Validation of skills and competences



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Executive Summary

The rapid expansion of the European battery ecosystem, driven by the green and digital transitions, is generating substantial demand for new and evolving competences across the value chain. Ensuring that these competences are consistently defined, assessed, validated, and recognised across Europe is critical for workforce mobility, industrial competitiveness, and the scalability of training provision.

Deliverable D2.4 of the VOLTAGE project provides a structured mapping and system-level analysis of existing European competence frameworks, self-assessment tools, and validation models relevant to the battery sector. The objective is to identify strengths, structural gaps, and enabling factors that may support the development of a coherent European validation and recognition ecosystem.

The analysis confirms that Europe already possesses many of the necessary building blocks for a robust validation system:

- European reference frameworks (e.g. DigComp, GreenComp, ESCO) provide shared conceptual foundations.
- Sector-specific competence frameworks (e.g. InnoEnergy) support alignment with the battery value chain.
- Sector-level operational platforms (e.g. ASA Skills Hub and associated skills cards) translate competences into usable job roles and learning pathways.
- National validation and recognition systems ensure institutional legitimacy.
- European digital credential infrastructures (ELM/EDC) enable portability and trust.

However, the ecosystem remains fragmented. The gap analysis identifies four structural challenges:

1. **Fragmentation across levels and instruments**, limiting interoperability.
2. **Uneven coverage of the battery value chain**, particularly for emerging job roles.
3. **Insufficient visibility of transversal digital and green competences** within sector-specific validation approaches.
4. **Lack of end-to-end coherence across the skills lifecycle**, with validation and recognition largely dependent on heterogeneous national systems.

These gaps do not result from the absence of tools or frameworks, but from limited alignment and interaction between them.

Based on the analysis, the report derives a set of design principles for strengthening validation in the battery sector:

- Interoperability should be embedded by design.
- Sector-level operationalisation is essential for relevance and agility.
- Transversal competences must be systematically structured and visible.
- End-to-end coherence should be achieved without creating a single European validation authority.
- European approaches must remain complementary to national validation systems.

These principles clarify the functional scope of a joint European validation framework and delineate roles across European, sectoral and national levels.

Within this landscape, the VOLTAGE project acts as a pilot environment for operationalising these principles. Through its network of Centres of Vocational Excellence, VOLTAGE explores how sector-level competence structures, national validation systems and European digital credential infrastructures can be connected in practice.

Rather than introducing new authorities or parallel systems, VOLTAGE contributes by testing structured interaction across levels and generating evidence on feasibility, limitations and scalability.

The findings of this deliverable demonstrate that a robust European validation and recognition ecosystem for the battery sector is feasible, provided that existing enablers are strategically aligned and operationalised. The battery sector may therefore serve as a pilot domain for structured European validation approaches supporting cross-border recognition in strategic industrial ecosystems.

List of Abbreviations

ALBATTTS – Alliance for Batteries Technology, Training and Skills

ASA – Automotive Skills Alliance

BEPA – Batteries European Partnership Association

CoVE – Centre of Vocational Excellence

CPD – Continuing Professional Development

D2.4 – Deliverable 2.4 (Mapping of European Validation Models)

DoW – Description of Work

EC – European Commission

ECVET – European Credit System for Vocational Education and Training

EDC – European Digital Credentials Infrastructure

EIT – European Institute of Innovation and Technology

ELM – European Learning Model

EQF – European Qualifications Framework

ESCO – European Skills, Competences, Qualifications and Occupations

ERP – Enterprise Resource Planning

EU – European Union

IEC – International Electrotechnical Commission

MES – Manufacturing Execution System

NQF – National Qualifications Framework

RPL – Recognition of Prior Learning

SME – Small and Medium-sized Enterprise

VET – Vocational Education and Training

VPL – Validation of Prior Learning

WP – Work Package

1. Introduction

The rapid expansion of the European battery ecosystem, driven by the twin green and digital transitions, is generating significant demand for new and updated competences across the entire value chain — from raw materials and cell manufacturing to system integration, second-life applications, and recycling. Addressing these needs requires not only the development of new training provision, but also the strengthening of mechanisms that support competence development, validation and cross-border recognition.

The VOLTAGE project aims to reinforce Centres of Vocational Excellence (CoVEs) in the battery sector and to contribute to a more coherent and responsive European skills ecosystem. Within this framework, **Work Package 2 (WP2)** focuses on three interconnected objectives:

- the capacity building of trainers and VET staff in the battery sector;
- the development and adaptation of curricula and training programmes among project partners;
- the development of European-oriented mechanisms for validation and recognition of competences in the battery sector.

Deliverable D2.4 is situated within this third objective. It provides an analytical foundation for the development of validation mechanisms by mapping existing European and national frameworks, tools and models, and by identifying structural gaps and enabling factors relevant to the battery ecosystem.

1.1 Purpose of the Deliverable

The purpose of this deliverable is to:

- Map existing competence frameworks relevant to the battery sector at European, national and sectoral levels;
- Analyse existing tools for self-assessment, validation and credentialing of skills;
- Identify systemic gaps affecting coherence, interoperability and cross-border recognition;
- Highlight existing enablers that can support the development of a more integrated validation approach;
- Derive evidence-based design implications for strengthening validation and recognition mechanisms in the battery sector.

The report adopts an ecosystem perspective. Rather than proposing a centralised validation authority, it examines how existing European reference frameworks, sector-level initiatives, national validation systems, and digital credential infrastructures interact — and where improved alignment could enhance transparency, portability, and recognition of competences.

1.2 Strategic Context

The battery sector is strategically critical for Europe's industrial competitiveness, energy transition and technological sovereignty. It is characterised by:

- Rapid technological evolution and emerging job roles;
- Strong integration of digital and sustainability competences;
- Cross-border value chains requiring workforce mobility;
- Increasing demand for upskilling and reskilling across education and industry.

In this context, fragmented validation and recognition mechanisms may hinder mobility, slow workforce adaptation, and limit the scalability of training solutions. Ensuring that competences can be consistently defined, assessed, validated, and recognised across national systems is therefore a key enabling factor for the development of a resilient European battery ecosystem.

This deliverable contributes to this objective by analysing the structural characteristics of the current validation landscape and identifying conditions under which greater coherence can be achieved.

1.3 Analytical Logic of the Report

The report follows a structured analytical progression:

1. **Methodological Approach (Chapter 2)** – Defines the analytical framework, mapping methodology, and comparative criteria used throughout the report.
2. **Mapping of Competence Frameworks (Chapter 3)** – Examines sectoral, national and transversal European competence frameworks relevant to the battery ecosystem.
3. **Mapping of Tools (Chapter 4)** – Analyses self-assessment instruments, validation tools, skills reference platforms, and digital credential infrastructures.
4. **System-Level Analysis (Chapter 5)** – Identifies structural and sector-specific gaps, highlights enabling factors, and derives design principles and functional implications for a joint European validation approach.
5. **Conclusions (Chapter 6)** – Synthesises key findings and clarifies how the VOLTAGE project can contribute to strengthening coherence, portability, and cross-border recognition in the battery sector.

This progression ensures that the report remains evidence-based and analytically grounded, with each section building logically on the previous one.

2. Methodological Approach

This report adopts a structured and comparative methodological approach in order to map, analyse, and interpret existing competence frameworks, validation tools, and models relevant to the battery sector in Europe. The methodology combines systematic mapping with lifecycle-based analysis and ecosystem-level interpretation, ensuring that conclusions are grounded in documented evidence rather than normative assumptions.

The methodological approach is designed to support three main objectives:

- to provide a structured overview of relevant European, national, and sectoral initiatives;
- to identify systemic gaps and limitations in the current validation and recognition landscape;
- to derive evidence-based design implications for a more coherent European approach.

2.1 Overall Analytical Framework

The analysis is based on an ecosystem perspective, recognising that skills validation and recognition in the battery sector involve multiple layers and actors operating at European, national and sectoral levels.

Rather than evaluating individual initiatives in isolation, the report examines how different elements interact across the **skills lifecycle**, including:

- competence definition and structuring;
- assessment and self-assessment;
- validation and formal recognition;
- certification and credentialing;
- portability and cross-border transparency.

This lifecycle-oriented perspective enables the identification of structural discontinuities, overlaps and fragmentation across stages and institutional levels.

2.2 Mapping Methodology for Competence Frameworks

The mapping of competence frameworks (Chapter 3) was conducted using a set of predefined analytical descriptors to ensure comparability and consistency across initiatives. Frameworks were selected based on their relevance to:

- the battery value chain;
- transversal digital and green competences;

- national or European-level recognition;
- emerging and future-oriented job roles.

Each framework was analysed against structured descriptors, including:

- value chain coverage;
- job roles and skills coverage;
- inclusion of emerging competences;
- alignment with EQF levels;
- association with curricula or training programmes;
- level of recognition (European, national, sectoral);
- integration capability with other systems;
- overall advantages and limitations.

This descriptor-based approach ensured that frameworks were assessed using consistent criteria, allowing for cross-comparison and synthesis.

2.3 Mapping Methodology for Self-Assessment and Validation Tools

The analysis of tools (Chapter 4) followed a similar structured approach, focusing on their functional characteristics and operational scope. Tools were analysed according to descriptors including:

- focus and scope;
- target group;
- assessment type and method;
- cost and duration;
- profiles and EQF levels covered;
- treatment of digital and green competences;
- feedback mechanisms and learning path integration;
- data privacy and security;
- certification and recognition features;
- interoperability and integration capability.

This approach enabled differentiation between tools that support self-assessment, structured assessment, validation, credentialing or combinations thereof.

2.4 Analytical Dimensions and Gap Identification

The comparative mapping of frameworks and tools was subsequently synthesised using four analytical dimensions:

- **Conceptual dimension** – how competences, job roles and learning outcomes are defined and structured.
- **Operational dimension** – how competences are translated into usable artefacts such as job role profiles, skills cards and learning pathways.
- **Validation and recognition dimension** – how competences are assessed, validated and formally recognised.
- **Portability and interoperability dimension** – how validated outcomes are expressed, shared and recognised across borders.

Gaps identified in Chapter 5 are derived directly from this structured analysis. The focus is on systemic and structural gaps, such as fragmentation, uneven coverage of the value chain, limited transversal competence integration, and weak end-to-end coherence.

The identification of gaps is therefore evidence-based and grounded in the comparative findings, rather than driven by predefined policy targets.

2.5 Synthesis Methods

To facilitate interpretation and comparison, the report employs several synthesis instruments, including:

- structured comparison tables;
- lifecycle mapping matrices;
- conceptual diagrams;
- SWOT analysis.

These tools are used to visualise patterns of fragmentation, complementarities, and structural limitations across the ecosystem.

The SWOT analysis presented in Chapter 5 synthesises findings from the mapping and gap analysis phases, providing a concise overview of strengths, weaknesses, opportunities and threats within the current European validation landscape.

2.6 Limitations of the Methodology

While the report draws on a wide range of documented initiatives, it does not claim to provide an exhaustive inventory of all competence frameworks and validation tools in Europe. Selection was guided by relevance to the battery sector, availability of information

and alignment with the objectives of this deliverable.

In addition, the analysis focuses on structural characteristics and interaction patterns rather than on the pedagogical quality or effectiveness of individual training programmes or assessment practices.

These limitations are considered appropriate given the strategic and exploratory nature of the report, whose primary aim is to inform the development of a coherent European validation ecosystem for the battery sector.

Concluding Note on Methodology

By combining structured mapping, comparative analysis, and lifecycle-based interpretation, this methodological approach provides a robust foundation for identifying gaps, enablers, and design implications within the European battery skills ecosystem. The subsequent chapters build on this framework to present the detailed mapping (Chapters 3 and 4), the gap analysis (Chapter 5), and the conclusions and forward-looking considerations (Chapter 6).

3. Competence Frameworks in the Battery Sector

3.1 Introduction to Competence Frameworks Mapping

This chapter presents a mapping of competence frameworks relevant to the battery sector in Europe. The identified frameworks differ significantly in scope, purpose and level of application, ranging from sector-specific competence models to national qualification systems and transversal European reference frameworks.

To ensure clarity and comparability, the frameworks analysed in this chapter are grouped into three categories: **sectoral competence frameworks**, **national qualifications and validation frameworks**, and **cross-cutting European reference frameworks**. Each framework is described using a common set of descriptors, focusing on coverage, structure, recognition and integration potential.

3.2 Sectoral Competence Frameworks

Sectoral competence frameworks are designed to address the specific skills and job roles required within a defined industrial domain. In the context of the battery sector, these frameworks typically focus on technical competences, occupational profiles, and value-chain-related activities, often developed in close cooperation with industry stakeholders.

3.2.1 InnoEnergy Battery Competence Framework

Overview and Scope

The InnoEnergy Battery Competence Framework (EIT InnoEnergy, 2023) is a European, industry-driven competence framework developed by InnoEnergy (formerly EIT InnoEnergy), an organisation initiated by the European Institute of Innovation and Technology (EIT). InnoEnergy operates across multiple energy-related sectors, with a strong focus on batteries through its Skills Institute and the European Battery Alliance (EBA) Academy (European Battery Alliance Academy, 2023).

The framework was designed as a practical reference tool to support workforce development across the battery value chain, responding to the rapid expansion of battery manufacturing and deployment in Europe. It targets vocational education and training (VET), higher education (HE), and continuing professional development (CPD), with a strong emphasis on industrial relevance rather than formal qualification standardisation (EIT InnoEnergy, 2023).

Value Chain Coverage

The framework provides comprehensive coverage of the battery value chain, including:

- Raw materials and processing
- Battery cell and pack manufacturing
- Battery systems integration and applications
- Second life applications
- Recycling and end-of-life processes

Competences are structured to reflect the technical and operational needs at each stage of the lifecycle, supporting both role-based and value-chain-based learning pathways (EIT InnoEnergy, 2023).

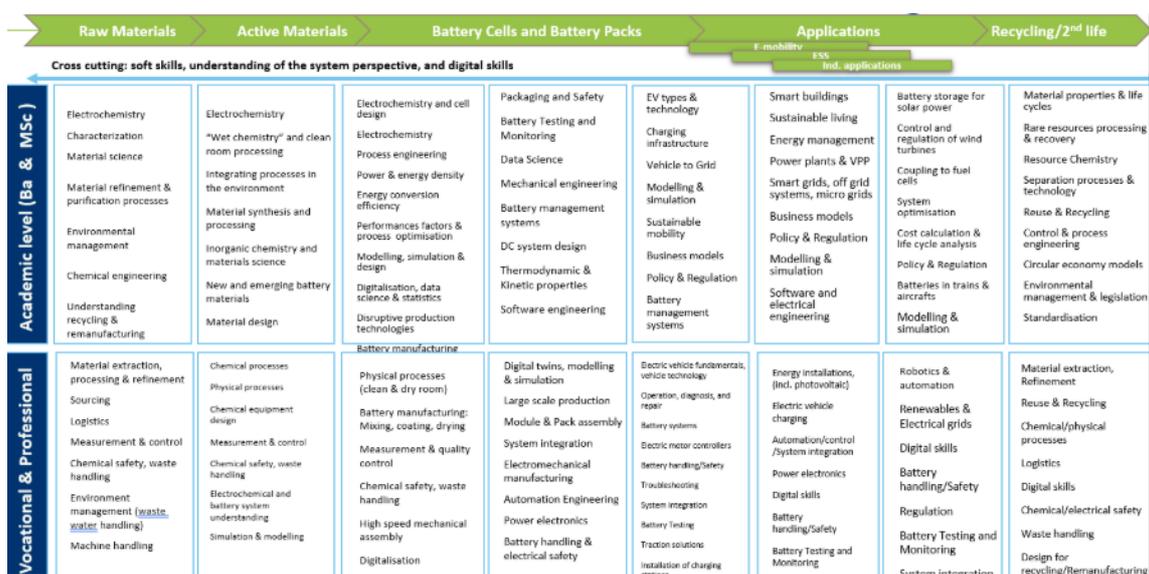


Figure 1 - InnoEnergy overview of skills needs across the battery value chain (Source: InnoEnergy Battery Competence Framework documentation)

Job Roles and Skills Coverage

Rather than defining a fixed list of occupations, the InnoEnergy framework adopts a modular and flexible approach to job roles and skills. Competences can be combined to reflect specific job profiles, company needs, or operational contexts.

The framework supports a wide range of professional profiles, including production operators, technicians, engineers, and supervisory roles. Skills are grouped into technical competences linked to value-chain stages, complemented by transversal digital and soft skills applicable across roles and qualification levels (EIT InnoEnergy, 2023) (InnoEnergy Skills Institute, 2022).

This design allows adaptation to both existing and emerging job roles, particularly in fast-evolving industrial environments.

Actual and Emerging Job Roles and Skills

The framework is explicitly designed to address current and emerging skills needs in the

European battery sector. Skills were identified through labour market analysis, industry consultation, and skills mapping activities coordinated by InnoEnergy and its partners within the European Battery Alliance (European Battery Alliance Academy, 2023) (InnoEnergy Skills Institute, 2022).

Key focus areas include:

- Scaling of battery manufacturing and gigafactories
- Digitalisation of production, monitoring, and maintenance
- Quality assurance and safety requirements
- Sustainability, recycling, and circular economy principles

This forward-looking orientation supports upskilling and reskilling aligned with Europe's green and digital transition objectives.

Competence Levels and EQF Alignment

Skills within the framework are defined across four proficiency levels: beginner, intermediate, advanced, and expert. These levels are described in terms of autonomy, responsibility, and the ability to perform tasks independently or supervise others (EIT InnoEnergy, 2023).

While the framework is applicable across VET and higher education contexts, explicit mapping to European Qualifications Framework (EQF) levels is not systematically formalised. EQF alignment depends on national or institutional implementation and is therefore variable across countries.

Courses, Curricula and Delivery Formats

The InnoEnergy Battery Competence Framework is closely linked to a broad portfolio of training offers delivered through the InnoEnergy Skills Institute and the European Battery Alliance Academy. These include:

- Online self-paced courses
- Blended learning programmes
- In-company and tailor-made training
- Short modular units and micro-credentials

Learning paths can be assembled according to job role requirements and individual skill gaps. The “Battery Driver’s Licence” concept illustrates this modular learning-path approach, allowing structured combinations of training units aligned with specific competence profiles (EIT InnoEnergy, 2023) (InnoEnergy, 2024).

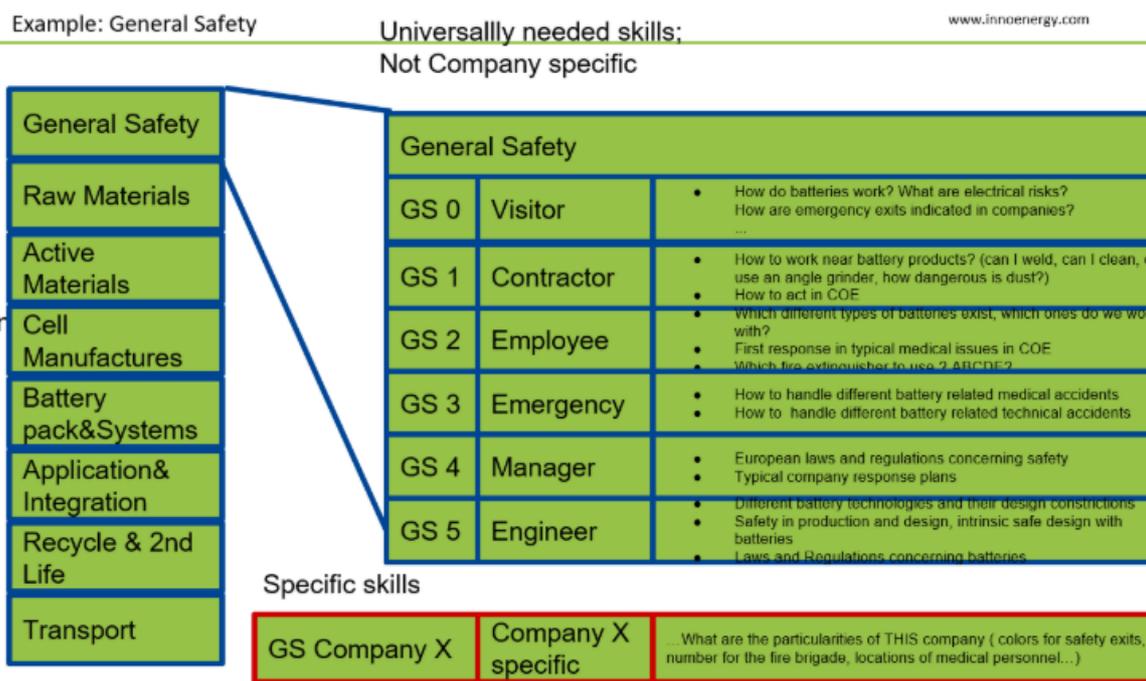


Figure 2 - Example of the InnoEnergy “Battery Driver’s Licence” modular learning-path concept (Source: InnoEnergy Skills Institute / EBA Academy material)

Target Groups

The framework addresses multiple target groups across the skills ecosystem, including:

- VET learners preparing for entry-level roles in the battery sector
- Skilled workers and technicians seeking upskilling or reskilling
- Engineers and professionals specialising in battery technologies
- Teachers and trainers adapting content to local curricula and training environments

This broad target-group coverage enables use across initial education, lifelong learning, and industrial training contexts.

Recognition and Integration Capability

The framework is recognised at European and sectoral level through its adoption by industry partners, training providers, and the European Battery Alliance Academy. However, it is not published as a fully open, standalone framework and is primarily implemented as a service through licensed training provision (European Battery Alliance Academy, 2023) (InnoEnergy, 2024).

Formal integration into national qualification systems and explicit EQF referencing remain limited and depend on country-specific initiatives. Nevertheless, the modular structure and use of micro-credentials facilitate integration into institutional curricula, company training systems, and Continuing Professional Development (CPD) pathways.

Language

Training content associated with the framework is delivered in several European languages. Core framework documentation and detailed competence descriptions are predominantly available in English, with localisation depending on training providers and national implementations (InnoEnergy, 2024).

Overall Advantages and Disadvantages

Advantages

- Full coverage of the battery value chain
- Strong industry alignment and European relevance
- Modular structure enabling flexible learning paths
- Multilingual course delivery
- Suitable for onboarding, upskilling, and reskilling

Disadvantages

- Limited formal EQF alignment at European level
- Framework documentation not fully open-access
- Variable recognition within national qualification systems
- Requires continuous updates to reflect rapid technological change

3.2.2 Automotive Skills Alliance Reference and Recognition Framework

Overview and Scope

The Automotive Skills Alliance (ASA) is a European multi-stakeholder partnership established under the European Commission's Pact for Skills to support the green and digital transformation of the automotive and mobility ecosystem. ASA was launched in November 2020 and became a legal entity (non-profit) in January 2022. (Automotive Skills Alliance, 2026)

Within ASA, the **Skills Hub** operationalises a sectoral **Reference and Recognition Framework** that connects: (i) skills intelligence and job role definitions, (ii) training provision, and (iii) micro-credentials (digital badges) issued at learning-outcome level

Scope note: Although the Skills Hub is a digital platform, the “framework” described here refers to the reference structure and mapping logic that ASA uses to define and recognise job roles, competences/knowledge concepts and learning outcomes across providers.

(Automotive Skills Alliance, 2026). The framework’s practical purpose is to enable cross-provider comparability and EU-wide portability of learning outcomes mapped to common competence/knowledge concepts and ultimately to job roles (Automotive Skills Alliance, 2026).

Value Chain Coverage

ASA’s framework targets the broader **automotive–mobility ecosystem**, including themes linked to electrification, automation, and connected mobility. The Skills Hub catalogue is organised into thematic areas spanning engineering, electrified powertrains, robotics/automation, digitalisation, and related transversal domains (Automotive Skills Alliance, 2026).

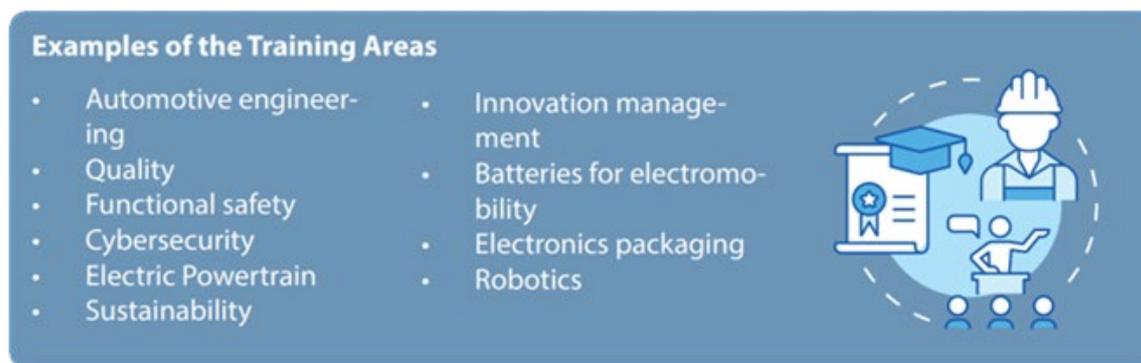


Figure 3 - Training areas covered in the Skills Hub catalogue (Source: (Automotive Skills Alliance, 2026))

Job Roles and Skills Coverage

The ASA framework is built around a structured mapping chain:

Learning outcomes → competence/skill and knowledge concepts → job roles / profiles.

Training providers map their courses and learning outcomes to the reference concepts, enabling consistent labelling and recognition across the ecosystem (Automotive Skills Alliance, 2026). This approach supports modular “stacking” of achievements from multiple providers towards defined role profiles, while keeping flexibility for local delivery formats.

The underlying job roles and learning outcomes build on sector skills intelligence developed through EU Blueprint initiatives (e.g., DRIVES, ALBATTIS) and are jointly agreed within the alliance (Automotive Skills Alliance, 2026).

Actual and Emerging Job Roles and Skills

ASA’s framework is explicitly oriented towards emerging competence needs driven by the twin transition, notably electrification, digital diagnostics, software integration, automation and cybersecurity (Automotive Skills Alliance, 2026).

The Skills Hub’s current catalogue includes automotive and battery-sector training as well as digital and sustainability-related themes (e.g., cybersecurity, LCA and sustainability),

consistent with ASA’s mission under the Pact for Skills (Automotive Skills Alliance, 2026).

EQF Levels and Competence Levels

The ASA digital badge model uses multi-level maturity concepts (e.g., Awareness/Practitioner/Expert) and distinguishes between skill/competence and knowledge, as well as attendance vs exam-based completion (Automotive Skills Alliance, 2026).

EQF alignment claimed/implemented through the badge and course mapping process, with clarity varying by provider/course.

Courses/Curricula Associated

The framework is directly linked to training provision via the Skills Hub catalogue and allied learning platforms. Courses can be delivered by multiple providers and mapped to the reference framework so that completion can result in the issuance of a sectoral badge (Automotive Skills Alliance, 2026).



Figure 4 - Platform highlights / architecture and user interface (Source: XXXXXX)

Language

The Skills Hub and associated learning environments are intended for EU-wide use and host courses from multiple providers. In practice, language availability depends on each provider and course; platform-level multilinguality is achieved through aggregation and mapping rather than a single-language framework publication.

Level of Recognition

Recognition is primarily **sectoral and European**, based on a “community recognition” approach among ASA members, where alliance stakeholders agree on common rules for mapping and accepting badges as evidence of competence.

The framework aims to complement evolving European micro-credential practices by providing a lightweight, cross-border recognition mechanism anchored in shared skills intelligence and provider-level assessment (Automotive Skills Alliance, 2026).

Integration Capability

ASA’s framework is explicitly designed for interoperability and portability through digital credentials. The Skills Hub describes a structured mapping process that connects

learning outcomes to reference competence/knowledge concepts and job roles, enabling EU-wide recognition of mapped training and badge awarding (Automotive Skills Alliance, 2026).

Badges are aligned with the Open Badges approach; in general terms, Open Badges are a portable, verifiable digital credential standard designed to carry metadata about skills and achievements (1EdTech Consortium Inc., 2026).

The ASA badge architecture follows a four-layer structure that defines the maturity level, content type, completion method, and recognition status:

Layer 1: Maturity level – Awareness, Practitioner, and Expert.

Layer 2: Concept type – Skill/Competence or Knowledge.

Layer 3: Type of completion – Attendance or Exam.

Layer 4: Recognition

- *Recognised (Gold)*: training or certification provided by an approved entity (e.g. DRIVES project).
- *Unrecognised (Grey)*: training not endorsed by a recognised entity or without certification.

Overall Advantages and Disadvantages

Advantages

- Provides a practical **reference and recognition structure** linking learning outcomes, competences/knowledge concepts, and job roles across providers.
- Supports modular, stackable recognition via micro-credentials, enabling learners to accumulate achievements towards job role profiles.
- Strong alignment with the automotive–mobility twin transition agenda (electrification, automation, digital skills) under the Pact for Skills context.
- Operates as a scalable ecosystem mechanism (multi-provider catalogue, shared mapping rules).

Disadvantages

- While the ASA Skills Hub provides extensive operational content through its digital platform, a fully consolidated and version-controlled framework specification (e.g., comprehensive job role listings, systematic EQF mappings, methodological documentation or controlled vocabularies) may not always be presented in a single, publicly accessible reference document. This may limit immediate transparency for external stakeholders seeking a formally structured framework overview.
- Recognition relies substantially on community trust and provider approval processes; cross-country standardisation and long-term sustainability are identified

as continuing challenges in the draft.

3.3 National Qualifications and Validation Frameworks

National qualifications and validation frameworks provide the structural backbone for competence recognition, certification and progression within individual countries. Although generally cross-sectoral, these frameworks play a critical role in determining how battery-related skills can be formalised, validated and aligned with European qualification levels. In this chapter, a description of the National Frameworks from the Partner Countries in Voltage is provided.

3.3.1 Swedish Integrated Qualifications and Validation System

Overview of the Swedish Validation and Qualifications System

Sweden has developed a comprehensive national approach to qualifications and validation that combines:

- a formal **national qualifications framework (SeQF)** referenced to the European Qualifications Framework (EQF);
- **industry-led competence standards** providing detailed descriptions of skills required in specific sectors;
- a legally regulated **Validation of Prior Learning (VPL)** process enabling recognition of skills regardless of how they were acquired.

Together, these elements form a coherent structure that supports lifelong learning, labour market relevance, mobility and comparability of qualifications and competences (Myndigheten för yrkeshögskolans, 2026).

Swedish Integrated Qualifications and Validation System

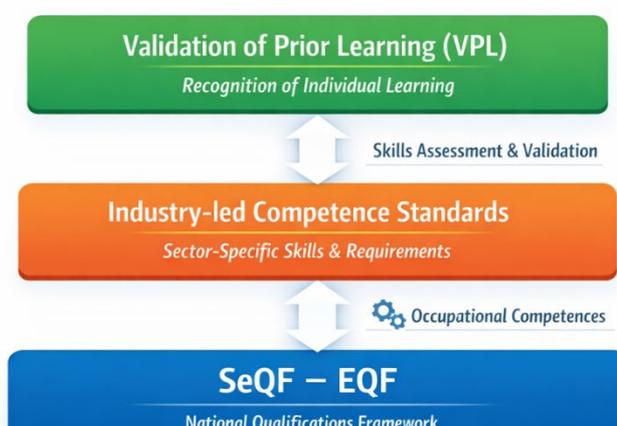


Figure 5 - Swedish Integrated Qualifications and Validation System. Relationship between SeQF/EQF, industry-led competence standards and Validation of Prior Learning (VPL)

Structural Framework: SeQF

The Swedish National Qualifications Framework (SeQF) was introduced in 2015 and is based on the European Qualifications Framework for Lifelong Learning (EQF). It comprises eight levels that correspond directly to the eight EQF levels and describe qualifications in terms of **learning outcomes** – what a holder knows, understands and is able to do (Myndigheten för yrkeshögskolans, 2026) (European Education and Culture Executive Agency, 2026).

SeQF applies to qualifications across formal, non-formal and informal learning and is maintained by the Swedish National Agency for Higher Vocational Education (MYH), which also serves as Sweden’s National Coordination Point for the EQF (Myndigheten för yrkeshögskolans, 2026).

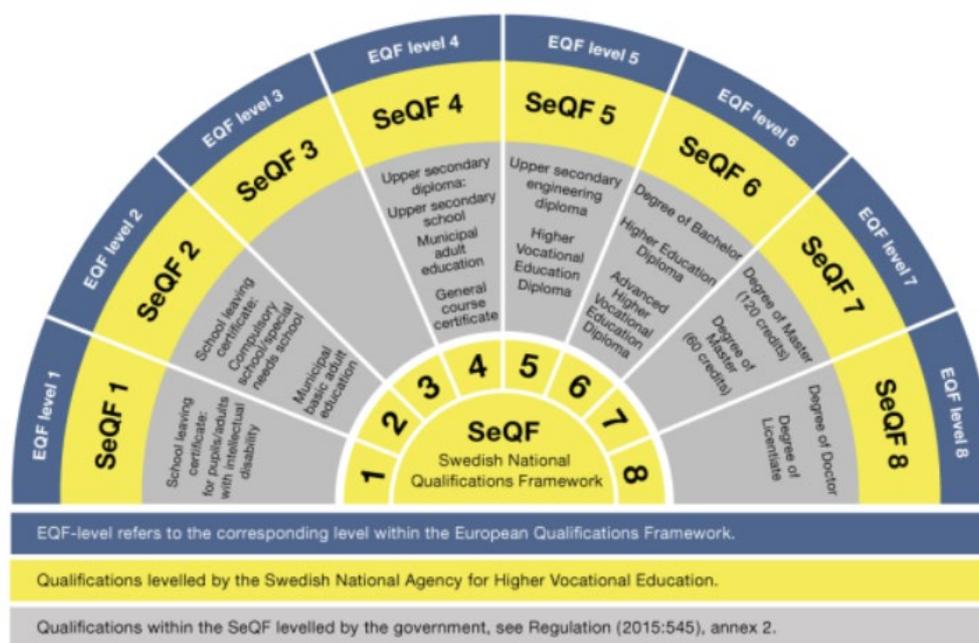


Figure 6 - SeQF and EQF alignment diagram (Source: Swedish National Agency for Higher Vocational Education, adapted from official SeQF documentation)

Sectoral Competence Definition: Industry-led Validation

In parallel with SeQF, Swedish industry organisations have developed **sector competence standards** for vocational roles in key sectors including manufacturing, automation and process operations. These standards describe the **skills, knowledge and responsibilities** expected for recognised occupational roles.

Once a sector competence standard is fully developed and includes appropriate learning outcomes and quality assurance, the responsible body can apply to MYH to have it **levelled to a SeQF level**. This enhances alignment between sector practice and the national framework (Myndigheten för yrkeshögskolans, 2021).

This layer ensures that **profession-specific competence descriptions** are available within the broader national structure, strengthening labour market relevance and facilitating alignment with formal education and training.

Recognition Process: Validation of Prior Learning (VPL)

Validation of Prior Learning (VPL) in Sweden is a nationally regulated process that enables recognition of competences regardless of the learning pathway – whether formal, non-formal or informal. VPL is implemented by education authorities, accredited validation centres and social partners, and is an integral mechanism linking **individual learning histories** to SeQF levels and, where relevant, to sector competence standards (CEDEFOP, 2026) (CEDEFOP, 2017).

This process supports reskilling and upskilling by providing formal acknowledgement of existing competences, enhancing employability and enabling access to further education pathways.

Value Chain and Job Role Coverage

Although not a sector-specific framework per se, the Swedish system supports coverage across the full battery value chain when sector standards and VPL assessments are applied within SeQF. The **national structure** provides a common language and level references (via EQF) while **sector validation mechanisms** define work-relevant competencies for specific occupations.

This means the system can flexibly incorporate emerging labour market needs – for example in electrification, digitalisation and automation – through updated standards and validation practices aligned with SeQF (European Education and Culture Executive Agency, 2026).

EQF Alignment and Integration Capability

SeQF is explicitly referenced to the EQF, meaning all SeQF levels correspond directly to a European level (EQF 1–8) and enhance international comparability. This alignment facilitates mobility for learners and workers across national borders and systems (Myndigheten för yrkeshögskolans, 2026).

Integration between SeQF, sector competence standards and VPL enables Sweden to link formal qualifications, national occupational practice and individual prior learning within a single overarching structure.

Language and Recognition

Documentation for SeQF and formal validation processes is primarily in Swedish, although key SeQF level descriptors and EQF referencing information are available in English through MYH and European repositories. The system enjoys **national recognition** and its connection to EQF supports **European recognisability** (Myndigheten för yrkeshögskolans, 2026).

Overall Advantages and Disadvantages

Advantages

- Holistic, lifelong learning-oriented national structure referenced to the EQF.

- Connects formal qualifications, industry needs, and individual validation processes.
- Facilitates labour market relevance, flexibility, and mobility.

Disadvantages

- As sectoral competence standards are developed within specific industry contexts, their structure, level of detail and degree of formalisation may vary across sectors. While this allows flexibility and responsiveness to labour market needs, it may limit uniformity and comparability when considered from a cross-sectoral or transnational perspective.
- VPL implementation can be decentralised, leading to variability in practice.

3.3.2 Portuguese Qualifications and Validation Framework

Overview and Scope

Portugal operates a comprehensive national system for qualifications and validation that enables the recognition and certification of competences acquired through formal, non-formal and informal learning. This system is anchored in the **National Qualifications System (Sistema Nacional de Qualificações – SNQ)** and structured through the **National Qualifications Framework (Quadro Nacional de Qualificações – QNQ)**, which is aligned with the European Qualifications Framework (EQF).

The framework supports initial education, vocational education and training (VET), continuing vocational education and training (CVET), and adult learning, providing a common reference for qualification levels, learning outcomes and validation processes across sectors of the economy, including automotive and energy-related activities.

Value Chain Coverage

The Portuguese framework is **cross-sectoral** by design and applicable across the full range of economic activities. While it is not tailored to a specific industrial value chain, it provides the structural mechanisms required to cover the **entire battery value chain** once sectoral qualifications, regulated competences or modular training units are defined and referenced within the national system.

In practice, battery-related competences are addressed through qualifications and training pathways linked to automotive maintenance, electrical systems, electrification, safety, and environmental compliance.

Job Roles and Skills Coverage

Job roles and skills are primarily defined through nationally recognised instruments, including:

- the **National Catalogue of Qualifications (CNQ)** for non-tertiary VET qualifications;

- learning outcomes described in terms of knowledge, skills and attitudes;
- sectoral standards and legally regulated competence requirements.

The framework supports both full qualifications and partial certification through modular units, enabling targeted skills development aligned with occupational profiles. This structure allows for periodic updating of job roles and skills in response to labour market needs, although update cycles depend on governance and sectoral involvement.

Actual and Emerging Job Roles and Skills

The framework is increasingly used to support **reskilling and upskilling** in response to technological change, digitalisation, and sustainability-driven transformation. In the automotive and energy sectors, emerging skills needs related to electrification, high-voltage systems, battery safety, and digital diagnostics are progressively incorporated through updated qualifications, modular training units, and regulated competence requirements.

While the framework provides mechanisms to address emerging skills, responsiveness varies depending on the speed at which sectoral standards and qualification profiles are revised.

EQF Levels and Alignment

The Portuguese National Qualifications Framework defines **eight qualification levels (1–8)**, fully aligned with the European Qualifications Framework. All formal qualifications and a significant share of non-formal learning outcomes can be referenced to an NQF/EQF level when delivered through recognised pathways.

EQF alignment is strongest for:

- regulated qualifications and VET pathways,
- Technological Specialisation Courses (CET),
- qualifications and partial certifications resulting from formal validation processes.

Courses, Curricula and Modular Provision

The framework supports a broad range of education and training offers, including:

- initial and continuing VET qualifications;
- Technological Specialisation Courses (CET);
- certified modular training units;
- adult education pathways;
- regulated competence attestations.

Modularity is a well-established characteristic of the system, particularly in CVET and adult learning, enabling flexible learning pathways and partial certification aligned with labour market needs.

Language and Recognition

Portuguese is the primary language of the framework and its associated instruments. Recognition is **national**, grounded in legislation and public governance, and supported by EQF alignment to ensure international comparability.

Qualifications and validation outcomes issued within the national system are formally recognised by education providers, public authorities and employers.

Integration Capability

The Portuguese framework demonstrates **strong internal integration**, connecting qualifications, modular training and validation of prior learning within a single national architecture. Digital systems support the traceability of certified learning outcomes and facilitate coordination between education, training and employment services.

Integration with non-formal, employer-driven and cross-border learning offers remains limited by the absence of common metadata standards and harmonised aggregation mechanisms.

Overall Advantages and Disadvantages

Advantages

- Robust national qualifications framework aligned with EQF
- Mature systems for VET, CVET and adult learning
- Legal mechanisms for validation of non-formal and informal learning
- Flexible modular structures supporting targeted upskilling

Disadvantages

- Fragmented recognition of short learning offers outside regulated pathways
- Limited transparency and portability of partial certifications across providers
- Uneven stackability and progression clarity between modular learning units
- Variable responsiveness to rapidly emerging technical skills

3.3.3 Turkish Qualifications and Occupational Standards Framework

Overview and Scope

Türkiye's competence and qualification system for technical and industrial sectors is structured around the **Türkiye Yeterlilikler Çerçevesi (TYÇ – Turkish Qualifications Framework)**, which is formally referenced to the **European Qualifications Framework (EQF)**. The framework is governed and operationalised through the **Vocational Qualifications Authority (MYK)**, which is responsible for

developing **National Occupational Standards (UMS)** and **National Vocational Qualifications (UY)**.

Within this national architecture, competence frameworks are primarily defined through occupational standards and performance-based qualifications. Battery technologies constitute a **new and emerging domain** within this system. While the overall framework is mature and well aligned with EQF principles, coverage of the battery value chain remains partial and uneven, with stronger representation in electric and hybrid vehicle maintenance and safety than in battery manufacturing, integration, and recycling.

Value Chain Coverage

The current Turkish framework provides **partial coverage of the battery value chain**.

Existing qualifications and standards focus mainly on:

- electric and hybrid vehicle maintenance,
- high-voltage safety,
- diagnostic and repair activities.

Coverage of upstream and mid-stream battery activities — such as materials processing, cell and module manufacturing, pack assembly, second-life applications and recycling — is limited or still under development. As a result, the framework currently addresses battery technologies primarily from a **downstream, maintenance-oriented perspective**, rather than from a full lifecycle approach.

Job Roles and Skills Coverage

Job roles and skills are defined through **MYK occupational standards (UMS)** and associated **vocational qualifications (UY)**. These standards specify:

- tasks and responsibilities,
- performance criteria,
- required knowledge and skills,
- assessment conditions.

In the context of battery technologies, existing job roles are largely related to:

- electric and hybrid vehicle technicians,
- maintenance and repair functions,
- safety-related competences.

The framework supports clear role definition and assessment consistency but is currently limited in the number of battery-specific occupational profiles.

Actual and Emerging Job Roles and Skills

Battery technologies are recognised as an **emerging competence domain** within the Turkish system. The document identifies several **missing or insufficiently covered job roles**, including:

- raw materials and processing technicians (e.g. cathode/anode preparation),
- cell and module assembly technicians,
- battery pack manufacturing and integration specialists,
- second-life and repurposing technicians,
- lithium-ion recycling operators,
- battery quality and testing technicians.

Recent updates (2023–2025) introducing qualifications in electric and hybrid vehicle maintenance represent an initial regulatory foothold. However, systematic coverage of emerging manufacturing- and recycling-related roles remains under development.

EQF Levels and Alignment

The Turkish Qualifications Framework (TYÇ) comprises **eight levels**, aligned with the EQF. Occupational standards and vocational qualifications developed by MYK are referenced to TYÇ levels, enabling transparency and European comparability.

EQF alignment is therefore **structurally strong** at framework level. The main limitation lies not in level referencing but in the **availability of battery-specific qualifications across multiple levels**, particularly at technician and specialist levels beyond maintenance.

Courses, Curricula and Academic References

Higher education institutions in Türkiye have begun to address competence gaps in battery technologies through dedicated and elective programmes, including:

- **Sabancı University – Battery Science & Engineering Minor (2024)**, covering battery chemistry, cell and pack manufacturing, testing, safety and BMS integration in collaboration with industry;
- graduate and elective courses in electrochemical energy storage, battery management systems and energy storage technologies at institutions such as **İstanbul Technical University, Yıldız Technical University, Marmara University and Ege University**;
- VET high schools and associate degree programmes in **Hybrid and Electric Vehicle Technology**, focusing on maintenance and applied skills.

These initiatives extend the competence landscape, but integration between academic learning outcomes and MYK vocational standards remains limited.

Language and Level of Recognition

The framework operates primarily in **Turkish** and holds **strong national recognition**, grounded in legislation and mandatory occupational standards. Through TYÇ–EQF referencing, the framework supports international transparency and comparability.

Recognition of academic qualifications is well established, while cross-recognition between academic pathways and vocational qualifications remains limited.

Integration Capability

Türkiye’s framework demonstrates **high structural integration** at national level, linking occupational standards, qualifications and assessment under MYK governance. Sector committees enable relatively rapid updating of standards in response to industrial needs.

However, integration between:

- vocational qualifications,
- academic programmes,
- short modular learning offers,

is still evolving, particularly in the battery domain. Mechanisms for recognising partial learning or modular outcomes across pathways are in an early or pilot stage.

Overall Advantages and Disadvantages

Advantages

- Mature national qualifications framework (TYÇ) aligned with EQF
- Strong governance through MYK and sector committees
- Clear occupational standards and performance-based assessment
- Rapid expansion of EV maintenance and high-voltage safety competences
- Growing university–industry ecosystem in battery technologies

Disadvantages

- Limited coverage of upstream and mid-stream battery manufacturing
- Recycling and second-life competences not yet formalised
- Battery-specific occupational standards still fragmented
- Weak articulation between academic and vocational pathways
- Limited recognition of modular or short learning offers

3.3.4 Finnish Qualifications and Validation Framework

Overview and Scope

Finland operates a comprehensive, competence-based national qualifications and validation system spanning initial, vocational, continuing and adult education. The system is anchored in the Vocational Education and Training Act (531/2017), national qualification requirements defined by the Finnish National Agency for Education (OPH), and the Finnish National Qualifications Framework (FiNQF), which is fully aligned with the European Qualifications Framework (EQF) (European Commission, 2026).

The Finnish system is built around learning outcomes and competence demonstration rather than study duration. Qualifications are obtained by demonstrating skills in authentic workplace contexts, regardless of where or how the competence was acquired. Recognition of prior learning (formal, non-formal and informal) is legally embedded and constitutes a subjective right of the learner (European Commission, 2026).

FiNQF includes eight levels (aligned to EQF levels 1–8) and covers the entire education system. Vocational qualifications are modular and structured into competence units that can be completed independently and accumulated toward full qualifications (European Commission, 2026).

Value Chain Coverage

The Finnish qualifications system is cross-sectoral by design and supports competence development across all major economic fields, including engineering, technology, energy, process industry, logistics and automation

Rather than creating battery-specific qualification pathways, Finland integrates battery-related competences into existing qualifications, such as:

- Vocational Qualification in Process Industry
- Vocational Qualifications in Vehicle Technology
- Vocational Qualifications in Electrical and Automation Engineering
- Vocational Qualification in Mechanical Engineering and Production Technology
- Further and Specialist Vocational Qualifications in Electrical Power Engineering

This structure enables coverage of the battery value chain (production, electrification, maintenance, recycling, logistics) through the integration of relevant competence units into established qualifications

Recent and forthcoming “digital green transition” units (2025–2027) further strengthen coverage in areas such as artificial intelligence, circular economy, emerging technologies and cybersecurity, which are highly relevant to the battery ecosystem

Job Roles and Skills Coverage

Job roles and competence requirements are defined through national qualification

requirements published in the ePerusteet system. Learning outcomes are expressed in terms of knowledge, skills and competences and are assessed through workplace-based demonstrations jointly evaluated by teachers and workplace representatives (Finnish National Agency for Education, 2026)

Qualifications consist of mandatory and optional competence units, enabling:

- Full qualifications
- Partial qualifications
- Modular upskilling pathways

The system allows individualised learning trajectories through Personal Competence Development Plans (HOKS), which identify prior learning and define tailored skill pathways

Actual and Emerging Job Roles and Skills

Finland's VET framework is continually updated in response to industrial transformation, digitalisation, sustainability and the green transition through updated qualifications, modular training units and regulated competence requirements. Recent development trends include:

- Skills for **electromobility, high-voltage systems, battery technology**, diagnostics and digital tools, increasingly integrated through updated or new vocational units and workplace-based demonstrations.
- A strong shift toward **green transition competences**, highlighted in OECD-aligned development of VET (OECD, 2026).
- Enhanced responsiveness through **Personal Competence Development Plans (HOKS)** that identify prior learning and define individual skill pathways.

Responsiveness varies by sector depending on update cycles of national qualification requirements and involvement of labour-market bodies.

EQF Levels

The Finnish National Qualifications Framework (FiNQF) consists of eight levels fully referenced to the EQF (completed in 2017).

Vocational education and training is primarily situated at:

- EQF Level 4 – Vocational upper secondary and further vocational qualifications
- EQF Level 5 – Specialist vocational qualifications

The framework ensures transparency, comparability and progression pathways, including access to higher education at EQF Level 6

Courses, Curricula and Modular Provision

Finnish VET is modular and competence-based. Qualifications are composed of competence units that may be independently completed and accumulated.

The system supports:

- Initial Vocational Education and Training (IVET)
- Further Vocational Qualifications
- Specialist Vocational Qualifications
- Apprenticeship pathways
- Continuing vocational training
- Recognition of prior learning (RPL)

There is no rigid structural separation between IVET and CVET; the same competence-based framework applies across age groups

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Level of Recognition

The Finnish system is fully regulated by national legislation and aligned with the EQF.

Qualifications are:

- Nationally regulated
- Recognised by employers and education providers
- Formally quality-assured
- Internationally comparable through EQF referencing

Recognition of prior learning is legally embedded and applies across education sectors (UNESCO, 2026).

Integration Capability

Finland demonstrates strong systemic integration across:

- Qualification standards
- Workplace-based learning
- Apprenticeship pathways
- Adult education
- Recognition of prior learning

Digital platforms (ePerusteet, Opintopolku) enhance transparency and traceability of certified learning outcomes.

However, short, non-regulated micro-credentials outside the national qualification structure may face limitations regarding standardisation and stackability unless formally referenced to qualification units.

Overall Advantages and Disadvantages

Advantages

- Fully competence-based and modular structure
- Strong legal embedding of validation of prior learning
- Workplace-oriented assessment and joint evaluation
- National standardisation with EQF alignment
- High adaptability through optional competence units
- Strong systemic integration across education sectors
- Clear support for digital and green transition competences

Disadvantages

- Formal updating of qualification requirements requires coordinated national processes, which may limit rapid responsiveness in fast-evolving industries.
- In newly emerging industrial fields, competence-based workplace demonstrations may be challenging where mature industry structures are still developing.
- Limited standardisation of short micro-credentials outside formal qualification units may affect transparency and portability unless formally integrated.

3.3.5 German Competence Framework Landscape for the Battery Sector

Overview and Scope

Germany does not operate a single, unified national competence framework specifically for the battery sector. Instead, skills development is structured through a multi-level ecosystem combining regional initiatives, national industrial strategies and EU-aligned reference frameworks (Deutscher Qualifikationsrahmen, 2013) (Kultusministerkonferenz, 2013) (Bundesministerium für Arbeit und Soziales, 2024).

The German approach is therefore decentralised, project-driven and modular rather than standardised through a single national framework.

- **Regional level initiatives** (led by federal states, clusters and consortia) are the most operational and influential (QualiBattBW, 2023) (QuW-LiB, 2025).
- **National strategies** (e.g. National Skills Strategy, BMBF programmes, IPCEI Batteries, DQR) provide strategic direction and funding but do not define binding battery-specific occupational standards (Bundesministerium für Arbeit und Soziales, 2024) (Bundesministerium für Bildung und Forschung, 2022) (European Commission, 2019) (European Commission, 2021).
- **EU reference frameworks** (EQF, ESCO, EU Battery Alliance recommendations) serve as alignment and comparability mechanisms (European Commission, 2008) (European Commission, 2022) (InnoEnergy, 2025).

This results in a flexible but heterogeneous competence landscape.

Value Chain Coverage

Collectively, existing competence frameworks and training initiatives cover the entire battery value chain, including (QualiBattBW, 2023) (QuW-LiB, 2025) (European Battery Alliance, 2017):

- Raw materials and materials processing
- Cell design and manufacturing (electrode production, cell assembly, formation)
- Module and pack assembly
- Application integration (automotive and stationary storage)
- Second-life applications
- Recycling and circular economy processes

This comprehensive value-chain coverage reflects Germany's industrial emphasis on manufacturing excellence, automotive integration and sustainability (European Commission, 2019) (European Commission, 2021) (SGL Carbon, 2021).

However, coverage is achieved through multiple regional and project-based initiatives rather than a single national reference framework.

Job Roles and Skills Coverage

Competence definitions are embedded within:

- Existing dual VET qualifications (e.g. mechatronics, industrial mechanics, automotive mechatronics)
- Continuing professional development programmes
- Industry-driven modular training initiatives
- Academic degree programmes in engineering, electrochemistry and materials science

Rather than defining battery-specific job roles at national level, Germany integrates battery competences into established occupational profiles and sectoral qualifications.

The German system builds on the strong dual VET tradition, where occupational standards are nationally regulated but sector-specific extensions (e.g. electromobility modules) are incorporated within existing frameworks.

Actual and Emerging Job Roles and Skills

Current competence development focuses on (QualiBattBW, 2023) (e-mobil BW GmbH, 2024) (QuW-LiB, 2025):

- Lithium-ion battery technologies
- Automotive and industrial battery applications
- Core manufacturing processes
- Quality control and process optimisation

Emerging competences increasingly addressed include (QualiBattBW, 2023) (QuW-LiB, 2025) (Erneuerbare Energien Hamburg, 2024) (InnoEnergy, 2025):

- Solid-state and next-generation battery technologies
- AI- and data-driven manufacturing and quality analytics
- Advanced recycling technologies
- Sustainability reporting and Battery Passport requirements

Germany's framework landscape therefore combines immediate industrial needs with forward-looking skill development linked to technological innovation (Bundesministerium für Arbeit und Soziales, 2024) (Bundesministerium für Bildung und Forschung, 2022) (European Commission, 2022).

EQF Levels and Alignment

German qualifications are mapped to (Deutscher Qualifikationsrahmen, 2013) (Kultusministerkonferenz, 2013) (Bundesinstitut für Berufsbildung, 2010) (European Commission, 2008):

- The European Qualifications Framework (EQF)
- The German Qualifications Framework (DQR – Deutscher Qualifikationsrahmen)

The DQR consists of eight levels aligned to the EQF and defines qualifications across four competence categories.

Typical alignment includes:

- **EQF/DQR Levels 3–4:** Skilled production operators and technicians
- **EQF/DQR Level 6:** Meister qualifications, engineers, process managers
- **EQF/DQR Levels 7–8:** Advanced academic and research roles (R&D engineers, doctoral researchers)

While EQF alignment ensures European comparability, battery-specific competences are not mapped through a dedicated national battery framework.

Courses, Curricula and Modular Provision

Competence frameworks are operationalised primarily through modular, practice-oriented curricula rather than standalone battery qualifications (QualiBattBW, 2023) (Technische Akademie für berufliche Bildung Schwäbisch Gmünd, 2023) (QuW-LiB, 2025) (Erneuerbare Energien Hamburg, 2021).

Examples include:

- Expansion of existing vocational programmes with electromobility modules (e.g. high-voltage systems, battery diagnostics) (Kultusministerkonferenz, 2023) (Kfz-Innung Mittelbaden, 2025)
- Regional initiatives such as QualiBattBW (39 modular training units covering cell production, digitalisation, quality management and recycling) (QualiBattBW, 2023) (Technische Akademie für berufliche Bildung Schwäbisch Gmünd, 2023) (e-mobil BW GmbH, 2024) (e-mobil BW GmbH, 2024) (Universität Stuttgart, 2023)
- National and EU-funded programmes (e.g. QuW-LiB) supporting re-skilling and continuing professional development (QuW-LiB, 2025) (Erneuerbare Energien Hamburg, 2021) (Erneuerbare Energien Hamburg, 2024) (Springer Professional, 2024)
- Academic degree programmes integrating battery-related content in engineering and materials science

Formal recognition is typically provided through (Deutscher Qualifikationsrahmen, 2013) (Kultusministerkonferenz, 2013) (Bundesministerium für Arbeit und Soziales, 2024) (Bundesinstitut für Berufsbildung, 2024):

- Certificates of participation
- Continuing education certificates
- Integration into existing vocational or academic qualifications

However, national standardisation of micro-credentials and short-cycle qualifications remains limited.

Language

German is the primary language of delivery for vocational and professional education.

In academic and research contexts, English is widely used, particularly in battery-focused degree programmes and research initiatives.

Level of Recognition

Recognition mechanisms operate primarily through:

- The nationally regulated dual VET system
- DQR/EQF alignment
- Formal academic degree recognition

However, many battery-specific training modules and micro-credentials are project-based and may not be uniformly standardised at national level.

Transferability is facilitated through EQF alignment but depends on integration within established qualification pathways.

Integration Capability

Germany demonstrates strong integration between:

- Industry
- Research institutions
- Regional clusters
- Training providers

The system is highly responsive and innovation-driven, with strong collaboration between stakeholders.

However, integration is largely achieved through coordination across projects and regions rather than through a unified national battery competence framework.

This decentralised structure supports flexibility but requires significant coordination effort.

Overall Advantages and Disadvantages

Advantages

- High flexibility through modular training provision
- Strong industry–research–education links
- Rapid responsiveness to technological change

- Comprehensive value-chain coverage
- Alignment with EU frameworks (EQF, ESCO)
- Strong dual VET tradition ensuring occupational relevance

Disadvantages

- Fragmentation across regions and projects
- Limited national standardisation of battery-specific competence frameworks
- Uneven regional availability and scalability
- High coordination effort for stakeholders
- Variable formal recognition of short-cycle and micro-credentials

3.4 Cross-cutting European Reference Frameworks

Cross-cutting European reference frameworks define transversal competences applicable across sectors, occupations, and levels of learning. These frameworks do not establish job roles, occupational standards, or validation mechanisms, but provide shared conceptual references that can be integrated into sectoral and national competence models.

They are analysed in this chapter as reference frameworks, not as sectoral or validation frameworks.

3.4.1 DigComp 3.0 – European Digital Competence Framework

Overview and Scope

The **Digital Competence Framework for Citizens (DigComp 3.0)** is a **European transversal competence framework** developed by the Joint Research Centre (JRC) of the European Commission. It provides a shared reference for defining, developing and understanding **digital competences** required for participation in society, education and the labour market.

DigComp is not a sectoral, occupational or qualification framework. Instead, it establishes a **common European language for digital competences**, applicable across all sectors and levels of learning, and intended to support policy development, curriculum design, self-assessment tools and skills monitoring initiatives.

Value Chain Coverage

DigComp is **value-chain agnostic** and applies horizontally across all economic activities. It does not target specific industrial processes or sectors, but its competences are relevant to **all stages of the battery and automotive value chain**, from manufacturing and maintenance to logistics, recycling and management.

Coverage is therefore **transversal**, supporting digital readiness rather than technical specialisation.

Job Roles and Skills Coverage

DigComp does **not define job roles** or occupational profiles. It defines **digital competences** grouped into five competence areas:

1. Information and data literacy
2. Communication and collaboration
3. Digital content creation
4. Safety
5. Problem solving

These competences are commonly used as complementary references alongside sector-specific technical skills and may be embedded into job profiles, training curricula or assessment tools.

Actual and Emerging Job Roles and Skills

DigComp explicitly addresses **emerging digital competence needs** arising from technological change, automation, and digitalisation. Regular updates ensure alignment with evolving digital practices, including cybersecurity, digital safety, and responsible technology use.

However, the framework does not translate emerging competences into **specific job roles or labour market profiles**, leaving contextualisation to sectoral frameworks and training providers.

EQF Levels

DigComp is **not formally referenced to EQF levels**. It includes proficiency levels that describe progression in digital competence acquisition, but these levels are **descriptive rather than normative** and are not intended to function as qualification levels.

Alignment with EQF may occur indirectly when DigComp-based learning outcomes are embedded within nationally referenced qualifications.

Courses, Curricula and Learning Pathways

DigComp is widely used as a **reference framework for curriculum design**, training programmes and learning pathways across Europe. It informs the development of digital skills curricula in formal education, VET, CVET and adult learning.

The framework is **non-prescriptive** and does not define mandatory courses or learning sequences.

Language and Level of Recognition

Project: 101143988 — VOLTAGE — ERASMUS-EDU-2023-PEX-COVE

DigComp is available in multiple European languages and benefits from **strong European-level recognition**, as it is endorsed and maintained by the European Commission. It is widely referenced in EU policy initiatives related to digital skills, employability and lifelong learning.

Integration Capability

DigComp demonstrates **high integration capability** as a transversal reference framework. It underpins a wide range of European tools and initiatives, including self-assessment instruments, monitoring tools and skills classification systems.

Its abstract and flexible design allows integration with sectoral competence frameworks, such as those related to batteries and automotive technologies, without imposing sector-specific constraints.

Overall Advantages and Disadvantages

Advantages

- Strong European legitimacy and policy alignment
- Clear and widely adopted structure for digital competences
- Applicable across all sectors and learning contexts
- High compatibility with tools, curricula and policy instruments

Disadvantages

- Does not define job roles or occupational standards
- Not designed for validation or certification
- Requires contextualisation to be operational at sector level
- EQF alignment is indirect and non-systematic

3.4.2 GreenComp – European Sustainability Competence Framework

Overview and Scope

The **European Sustainability Competence Framework (GreenComp)** is a **cross-cutting European reference framework** developed by the Joint Research Centre of the European Commission. It defines the key competences individuals need to contribute to the **green transition**, sustainability and long-term societal resilience.

GreenComp is not a sectoral or occupational framework. It establishes a **shared conceptual reference** for sustainability competences that can be applied across education, training, employment and policy contexts.

Value Chain Coverage

GreenComp applies **horizontally across all value chains**. It does not target specific industrial processes or sectors, but its competences are relevant to sustainability challenges throughout the **entire battery and automotive lifecycle**, including resource use, production, operation, end-of-life and circularity.

Job Roles and Skills Coverage

GreenComp does **not define job roles or technical skills**. It defines **sustainability competences** organised into four competence areas:

1. Embodying sustainability values
2. Embracing complexity in sustainability
3. Envisioning sustainable futures
4. Acting for sustainability

These competences relate to values, systems thinking, critical reflection, participation and transformative action. They coexist with technical and digital skills frameworks but do not, by themselves, define occupational profiles.

Actual and Emerging Job Roles and Skills

GreenComp strongly addresses **emerging transversal competences** required for the green transition, such as systems thinking, dealing with uncertainty, ethical decision-making and collective action.

The framework does not map these competences to specific emerging job roles, leaving such translation to sectoral frameworks and labour market instruments.

EQF Levels

GreenComp is **not explicitly referenced to EQF levels**. It adopts a flexible progression logic intended to support lifelong learning rather than formal qualification alignment.

Any EQF referencing must be implemented externally when GreenComp competences are embedded in formal qualifications or training standards.

Courses, Curricula and Learning Pathways

GreenComp is intended as a **guiding framework for curriculum development** and learning design. It supports the integration of sustainability competences into existing courses, programmes and learning pathways across all levels of education and training.

It does not prescribe curricula, courses or learning outcomes.

Language and Level of Recognition

GreenComp is available in multiple European languages and benefits from **high**

European-level recognition, supported by the European Commission and embedded in EU sustainability and education policy initiatives.

Integration Capability

GreenComp demonstrates **very high integration capability** as a transversal framework. It can be combined with sectoral competence frameworks, digital competence frameworks (such as DigComp) and occupational standards to enrich professional profiles with sustainability dimensions.

However, it does not provide operational mechanisms for assessment or validation.

Overall Advantages and Disadvantages

Advantages

- Strong alignment with the European Green Deal and sustainability policies
- Holistic and forward-looking competence model
- Applicable across sectors and education levels
- Complements technical and digital competence frameworks

Disadvantages

- High level of abstraction
- No linkage to job roles or qualifications
- Not designed for assessment or validation
- Requires translation into sector-specific contexts

4. Existing tools for self-assessment and validation of skills

4.1 Introduction to Tools Mapping

This chapter presents a mapping of existing European and national tools relevant to self-assessment, skills monitoring, learning guidance, credential issuance and validation. The identified tools serve different purposes and operate at different levels, ranging from population-level benchmarking instruments to individual self-assessment tools and digital credential infrastructures.

To support a clear and functional comparison, the tools analysed in this chapter are grouped according to their primary function within the skills ecosystem.

4.2 Monitoring and Benchmarking Tools

These tools are designed to measure and monitor skills at aggregate level, supporting policy development, benchmarking and large-scale diagnostics rather than individual validation.

4.2.1 Digital Skills Index (DSI 2.0)

Focus

The **Digital Skills Index (DSI 2.0)** is a European tool designed to **measure and monitor digital competence levels across the population**. It operationalises the **Digital Competence Framework (DigComp)** and is primarily used to track progress towards European policy targets, notably the Digital Decade objective that at least 80% of adults should have basic digital skills.

The tool's primary function is **statistical measurement and benchmarking**, rather than individual skills validation or vocational assessment.

Scope

The scope of DSI 2.0 is **pan-European**, covering all EU Member States. It serves as the main data source for the digital skills component of the **Digital Economy and Society Index (DESI)** and enables cross-country comparison of digital competence levels.

DSI 2.0 is cross-sectoral and applies to the general population, including individuals working in the automotive and battery value chains.

Target Group

The primary target groups are:

- the general adult population in the European Union;
- policymakers and public authorities responsible for monitoring digital skills development.

The tool is **not designed for individual career guidance or vocational certification purposes**.

Assessment Type

DSI 2.0 performs a **scored, empirical assessment** of digital skills.

Unlike self-assessment tools, it relies on **behaviour-based indicators** derived from statistical surveys rather than user self-perception.

Assessment Method

Assessment is based on **proxy indicators**, calculated from responses to Eurostat's Information Society surveys. Digital skills levels are inferred from the frequency and type of digital activities performed by individuals over a defined period.

This method allows for robust statistical comparison but does not directly test practical performance in controlled environments.

Cost of Assessment

The assessment is **free of charge**, as DSI 2.0 is an official European statistical instrument.

Testing Duration

The underlying survey typically takes **10 to 20 minutes** to complete, depending on the version and respondent profile.

Profiles Covered

Individuals are categorised into four proficiency levels:

- No digital skills
- Limited digital skills
- Basic digital skills
- Above basic digital skills

These categories provide a high-level profile of digital competence distribution within populations.

EQF Levels

DSI 2.0 does **not map digital competence levels to EQF levels (1–8)**.

Instead, it uses proficiency descriptors aligned with DigComp, serving policy monitoring

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purposes rather than qualification referencing.

Competencies Evaluated

The tool covers **all competence areas defined in DigComp**, including:

- information and data literacy;
- communication and collaboration;
- digital content creation;
- safety;
- problem solving.

A total of **21 DigComp competences** are indirectly assessed through behavioural indicators.

Actual / Emerging Skills

DSI 2.0 was modernised between **2019 and 2022** to align with DigComp 2.0 and to reflect evolving digital behaviours. While it captures trends over time, it does not explicitly distinguish emerging skills at occupational level.

Sector-Specific Skills

The tool measures **general digital skills** applicable across all sectors, including the battery value chain. It does not assess sector-specific or role-specific digital competences.

Language

DSI 2.0 is available in **all official EU languages**, as part of the Eurostat survey infrastructure.

Feedback to User

DSI 2.0 provides **score-based feedback at aggregate level**, primarily intended for statistical interpretation rather than individual guidance.

At individual level, respondents may be informed of their proficiency category (e.g. basic or above basic digital skills), but the tool does not provide personalised feedback, diagnostic gap analysis or learning recommendations.

Mass Reporting for Institutions

Aggregated results and cross-country comparisons are published annually by the European Commission as part of DESI reporting and related policy instruments.

Frequency of Updates

Updates occur **periodically**, typically in response to revisions of DigComp or significant changes in digital practices, such as the transition from the original DSI to DSI 2.0.

Associated Courses / Curricula

There is **no direct link** to specific courses or curricula. DSI 2.0 results are primarily used to inform policy design, curriculum development and large-scale upskilling strategies.

Certification

DSI 2.0 does **not issue certificates** and is not intended for individual validation or certification purposes.

Data Privacy & Security

As part of official EU statistical data collection, DSI 2.0 fully complies with **GDPR and Eurostat data protection requirements**.

Integration Capability

The tool demonstrates **high integration capability at policy and analytical level**, due to its scientific robustness and alignment with DigComp. It supports reliable cross-country comparison and identification of demographic and skills gaps but has limited integration with vocational validation or learning platforms.

Overall Advantages and Disadvantages

Advantages

- Scientifically robust and empirically validated
- Enables reliable cross-country and longitudinal comparison
- Strong alignment with DigComp and EU digital policy objectives
- Supports evidence-based policymaking

Disadvantages

- Primarily a statistical monitoring instrument
- No vocational validation, certification or job-role-specific assessment
- Limited relevance for individual learning pathways or sector-specific skills development

4.3 Self-Assessment and Reflection Tools

Self-assessment and reflection tools support individual or organisational awareness of competence levels and development needs. They rely primarily on self-reported information and provide orientative or diagnostic feedback, without formal validation or certification.

4.3.1 Overview and Common Characteristics

The self-assessment tools analysed in this section are designed to support **reflection, awareness and orientation regarding digital competences**, primarily aligned with the **European Digital Competence Framework (DigComp)**. They are widely used across Europe in education, training and adult learning contexts.

Despite differences in target groups and depth, these tools share several core characteristics:

- they rely on **self-reported information** rather than observed or tested performance;
- they provide **orientative or diagnostic feedback**, not formal validation;
- they do **not issue certificates** nor support EQF-referenced recognition;
- they are **cross-sectoral** and not linked to specific job roles.

As such, they are best understood as **entry-point or baseline tools**, supporting awareness and learning planning rather than competence validation.

The following self-assessment tools are included in this group:

- **SELFIE** (Schools and Teachers)
- **DigSAT**
- **MyDigiSkills**

Each tool addresses different audiences and use cases, while remaining within the same functional category (Table 1).

Table 1 - Comparative Summary of Self-Assessment Tools

Tool	Target Group	Level of Use	Feedback Type	Certification
SELFIE	Organisations	Institutional	Reflective / Aggregated	No
DigSAT	Individuals	Intermediate	Diagnostic (self-reported)	No
MyDigiSkills	Individuals	Basic	Awareness-oriented	No

4.3.2 SELFIE (Schools and Teachers)

Focus: Institutional self-reflection on the use of digital technologies for teaching and learning.

Target Group: Schools, VET providers, teachers, trainers and school leaders.

Assessment Type: Organisational self-assessment.

Feedback to User: Provides **aggregated and visual feedback** (dashboards and comparative results) at institutional level, supporting reflection and improvement planning. No individual diagnostic or skills validation feedback is provided.

Certification: No.

Key Note: SELFIE is a **strategic reflection tool** for organisations, not an individual competence assessment instrument.

4.3.3 DigSAT – Digital Skills Assessment Tool

Focus: Individual self-assessment of digital competences aligned with DigComp.

Target Group: Adult learners, workers and jobseekers.

Assessment Type: Self-assessment questionnaire.

Feedback to User: Provides **diagnostic, self-perceived feedback** on digital competence levels and highlights areas for improvement. Feedback is orientative and not validated.

Certification: No.

Key Note: DigSAT is suitable for **initial diagnostics and learning orientation**, but results remain self-reported.

4.3.4 MyDigiSkills

Focus: Awareness-raising and basic self-reflection on digital skills.

Target Group: General adult population, particularly users with limited prior exposure to digital competence frameworks.

Assessment Type: Light self-assessment.

Feedback to User: Provides **simple, awareness-oriented feedback**, encouraging further learning and skills development. No gap analysis or validation is performed.

Certification: No.

Key Note: MyDigiSkills prioritises **accessibility and inclusion**, rather than depth or diagnostic precision.

4.3.5 Overall Advantages and Disadvantages

Advantages

- support **baseline awareness** of digital competences;
- can be used as **entry points** for upskilling and reskilling pathways;
- align well with DigComp and EU digital policy objectives.

Disadvantages

- do not support **formal validation or certification**;
- are not linked to **job roles, sector-specific skills or EQF levels**;
- rely entirely on **self-reported data**, limiting their use for recognition of prior learning.

These tools are designed to support reflection, awareness, and orientation regarding digital competences.

4.4 Standardised Digital Competence Tests

These tools provide standardised, score-based measurements of digital competences through predefined assessment items. While more objective than reflective self-assessment tools, they do not constitute formal validation mechanisms.

4.4.1 IT Fitness Test

Focus

The **IT Fitness Test** is a **standardised digital competence test** designed to measure **basic and intermediate digital skills** through objective, score-based assessment items. Unlike reflective self-assessment tools, it aims to provide a **quantitative indication of digital competence levels** based on user performance.

The tool is primarily used for **baseline measurement, benchmarking and awareness-raising**, particularly in education, employment services and workforce development contexts.

Scope

The IT Fitness Test is used at the **national and regional level**, notably in Nordic and other European contexts, and is applicable across sectors. Its focus is transversal digital competence rather than sector-specific or occupational skills.

The tool is suitable for large-scale deployment in education, training and labour market initiatives.

Target Group

The primary target groups include:

- adult learners and jobseekers,
- students in VET and adult education,
- employees participating in digital upskilling initiatives,
- public authorities and organisations conducting digital skills diagnostics.

The tool is not tailored to specific job roles or professions.

Assessment Type

The IT Fitness Test performs a **standardised, score-based assessment** of digital competences.

Assessment is **auto-administered** but based on predefined questions with correct and incorrect answers, rather than on self-perception.

Assessment Method

The assessment method is based on:

- multiple-choice and task-oriented questions,
- predefined scoring rules,
- aggregation of results into competence levels or categories.

The test evaluates what users **know and can demonstrate conceptually**, rather than observing performance in real work situations.

Cost of Assessment

Access conditions depend on national or institutional implementation. In many cases, the test is offered **free of charge** within publicly funded education, employment, or upskilling programmes.

Testing Duration

The test typically takes **30–45 minutes** to complete, depending on the version and configuration used.

Profiles Covered

The IT Fitness Test produces **generic individual digital competence profiles**, usually expressed as:

- overall score,
- proficiency category (e.g. basic / intermediate),

- sometimes sub-scores by competence area.

Profiles are not occupationally specific.

EQF Levels

The IT Fitness Test does **not reference EQF levels**.

Results are expressed in tool-specific proficiency scales or score ranges and are not formally linked to national qualification frameworks.

Competencies Evaluated

The test evaluates **general digital competences**, typically aligned conceptually with DigComp areas, such as:

- information and data handling,
- communication and collaboration tools,
- basic digital content creation,
- digital safety and security,
- problem solving in digital contexts.

Actual / Emerging Skills

The IT Fitness Test focuses primarily on **established and foundational digital skills**. While content may be periodically updated, the tool is not designed to track emerging or advanced occupational digital competences.

Sector-Specific Skills

The test is **sector-neutral** and does not address industry-specific or job-role-specific digital skills.

Language

Language availability depends on national implementations. The test is available in several European languages in contexts where it has been adopted.

Feedback to User

The IT Fitness Test provides **score-based feedback** to users.

Feedback typically includes:

- an overall score or competence level,
- sometimes breakdowns by competence area,
- comparative positioning against predefined benchmarks.

Feedback is **informative and diagnostic**, but does not include learning recommendations, validation decisions, or certification.

Mass Reporting for Institutions

The tool supports **aggregated reporting and benchmarking** at the institutional, regional, or national level, making it suitable for workforce and education system diagnostics.

Frequency of Updates

Updates depend on the managing organisation and implementation context. Revisions typically aim to maintain relevance to evolving digital competence frameworks.

Associated Courses / Curricula

There is **no direct linkage** to specific courses or curricula. Results may be used by institutions to inform training design or guidance activities.

Certification

The IT Fitness Test does **not issue certificates** and does not constitute formal validation of competences.

In some contexts, results may be used internally for guidance or placement purposes, but they do not carry formal recognition.

Data Privacy & Security

Data protection and privacy practices depend on the implementing organisation. In public-sector deployments, data handling typically complies with GDPR requirements.

Integration Capability

The IT Fitness Test demonstrates **moderate integration capability**. It can be embedded into education, employment, and workforce development programmes, but integration with qualification frameworks, validation systems, or European credential infrastructures is limited.

Overall Advantages and Disadvantages

Advantages

- Objective, score-based measurement of digital competences
- More robust than purely reflective self-assessment tools
- Suitable for large-scale diagnostics and benchmarking
- Useful for baseline measurement in upskilling initiatives

Disadvantages

- No formal validation or certification
- No linkage to EQF, job roles or sector-specific skills
- Limited support for learning pathways or competence recognition

4.5 Skills Reference, Learning Pathway, and Interoperability Tools

This category includes tools that support **skills transparency, competence referencing, and interoperability** across education, training, and labour market systems. Rather than assessing or validating competences, these tools provide **common languages, structures, and interfaces** that enable individuals, training providers, employers, and institutions to describe, map, and relate skills, qualifications, and learning opportunities in a consistent way.

The tools analysed in this section facilitate **skills visibility and navigation**, support the alignment of competences with job profiles and learning pathways, and contribute to interoperability within the European skills ecosystem by relying on shared reference frameworks and data models.

4.5.1 ESCO – European Skills, Competences, Qualifications and Occupations

Focus

ESCO is the **European multilingual classification of skills, competences, qualifications, and occupations**. Its primary focus is to provide a **common reference language** for describing occupations and skills in a structured, comparable, and interoperable way across Europe.

ESCO is **not** a skills assessment tool, a validation method, or a training framework. Instead, it functions as an **enabling infrastructure** that supports self-assessment, validation, and matching processes carried out by other systems.

Scope

The scope of ESCO is **pan-European and cross-sectoral**. It covers all major economic sectors and occupational domains, including those relevant to the automotive and battery value chain.

ESCO is publicly available through an online portal and is designed to support interoperability across national, sectoral, and European systems.

Target Group

ESCO addresses a wide range of users and stakeholders, including:

- individuals describing their skills and experience,
- employers and recruiters,
- education and training providers,
- public employment services,
- policymakers and labour market analysts,
- developers of digital career, matching, and validation tools.

Assessment Type

ESCO does **not perform an assessment**.

It supports:

- self-assessment, when individuals select and describe skills using ESCO terminology;
- validation, when education providers or employers assess learning outcomes and describe them using ESCO skill concepts.

Assessment Method

ESCO provides:

- structured descriptions of occupations, including essential and optional skills;
- a controlled vocabulary of skill and competence concepts;
- explicit relationships between occupations, skills and qualifications.

Assessment and validation are carried out externally by other systems, which may reference ESCO to describe outcomes consistently.

Cost of Assessment

ESCO is **free of charge**, as it is developed and maintained by the European Union.

Testing Duration

ESCO does not include testing or time-based assessment.

Profiles Covered

ESCO includes:

- occupational profiles with typical skill requirements;

- skill and competence concepts applicable across roles and sectors;
- references to qualifications where available.

Profiles are generic and descriptive, not evaluative.

EQF Levels

ESCO does **not assign EQF levels** to individual skills.

EQF-related information may appear indirectly when qualifications linked to ESCO already have an EQF level through national referencing processes. ESCO uses the EQF definition of “skill” as a learning outcomes concept, but does not operate as a qualification framework.

Competencies Evaluated

ESCO does **not evaluate competences**.

It enables a consistent description of:

- technical skills,
- transversal competences,
- knowledge areas,
- occupation–skill relationships.

Actual / Emerging Skills

ESCO supports the identification and description of **emerging skills** by:

- updating occupation and skill profiles over time,
- enabling labour market analysis through large datasets (vacancies, CVs, training offers),
- supporting automated text analysis of learning outcomes linked to ESCO concepts.

However, the tool itself does not label skills as emerging.

Sector-Specific Skills

ESCO covers sector-specific skills, including those relevant to automotive, electrification and battery-related activities. Where additional granularity is required, ESCO allows **sectoral extensions**, provided they remain linked to the core ESCO structure.

Language

ESCO is multilingual and covers all official EU languages, as well as some additional languages. This multilingual design supports cross-border use and comparability.

Feedback to User

ESCO does **not provide direct feedback to individual users**.

Any feedback experienced by users is generated by external systems that implement ESCO (such as job matching platforms, guidance tools or validation systems). ESCO itself functions exclusively as a **reference and classification layer** and does not include feedback, guidance or progress-tracking functionalities.

Mass Reporting for Institutions

ESCO enables mass reporting and analysis **indirectly**, by serving as a common classification layer for:

- labour market intelligence,
- skills demand analysis,
- policy monitoring.

Frequency of Updates

ESCO is updated periodically at European level to reflect changes in occupations, skills, and labour market needs.

Associated Courses / Curricula

ESCO is not directly linked to courses or curricula.

However, learning outcomes of qualifications and training programmes can be mapped to ESCO skills to improve transparency and comparability.

Certification

ESCO does **not issue certificates** and does not validate learning outcomes. It supports certification processes by providing a consistent language for describing what has been achieved.

Data Privacy & Security

ESCO itself does not process personal data. Data protection and privacy depend on the systems that implement ESCO.

Integration Capability

ESCO demonstrates **very high integration capability**. It is:

- mandated or mapped under EU regulation for employment services (EURES),
- integrated into Europass for skills and occupation suggestions,
- used in national public employment systems either directly or via mappings,

- compatible with European Digital Credentials for Learning (EDC).

ESCO functions most effectively as a **shared interoperability layer** across European and national systems.

Overall Advantages and Disadvantages

Advantages

- Provides a common European language for skills and occupations
- Strong interoperability and cross-border comparability
- Supports job matching, labour market analysis and transparency
- Enables diverse systems to implement assessment and validation while maintaining their own governance models

Disadvantages

- Does not assess, validate or certify skills
- Requires implementation by external systems to deliver user value
- Sector-specific detail may require extensions

4.5.2 Europass CV online

Focus

The Europass CV Online is a European digital tool designed to support the **standardised documentation and presentation of skills, qualifications and experience**. Its primary focus is not direct skills assessment or validation, but rather **skills transparency, self-declaration and comparability** in the context of employment, education and mobility across Europe.

The tool contributes indirectly to validation processes by providing a structured environment aligned with European reference frameworks.

Scope

The scope of Europass CV Online is **pan-European**, covering all EU Member States and several associated countries. It is applicable across all sectors and occupational domains, including the automotive and battery sectors, and supports both education- and employment-related use cases.

The platform is available in 31 languages and is intended for cross-border use.

Target Group

The primary target groups include:

- jobseekers and workers at all qualification levels,
- students and graduates,
- career changers,
- individuals applying for education, training, volunteering or mobility programmes (e.g. Erasmus+).

The tool is used both by individuals and by institutions recommending a common CV format.

Assessment Type

Europass CV Online is a **self-declaration and documentation tool**. It does not perform skills testing, validation or formal assessment.

Assessment Method

Skills, qualifications and competences are documented through:

- structured data entry by the user,
- guided self-description of experience and learning outcomes,
- self-assessment of language skills using the CEFR scale (A1–C2),
- selection of skills and occupations supported by ESCO-based suggestions.

All information entered is **self-reported** and not independently verified by the platform.

Cost of Assessment

The tool is **free of charge** for all users, as it is provided and maintained by the European Union.

Testing Duration

There is no fixed testing duration.

Initial CV creation may take between **20 and 60 minutes**, depending on the completeness of the user's profile. Updates and tailored versions can be generated in a few minutes once a profile is established.

Profiles Covered

The tool supports **generic individual profiles** applicable across sectors and occupations. It does not define or assess formal occupational profiles but allows users to describe experience in relation to job roles and activities.

EQF Levels

EQF levels are **not automatically assigned or validated** by the platform.

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Users may manually reference EQF levels where their qualifications are officially linked to the EQF through national qualification frameworks or diploma supplements.

Any EQF referencing within the Europass CV remains **self-declared**.

Competencies Evaluated

The tool does not evaluate competencies. It allows users to document:

- technical skills,
- transversal competences,
- digital skills,
- language competences,
- certificates and qualifications.

ESCO-powered suggestions support consistency in terminology but do not constitute assessment.

Actual / Emerging Skills

Europass CV Online supports the documentation of **current and emerging skills** insofar as they are included in the ESCO database or manually entered by users. The tool itself does not distinguish between emerging and established skills.

Sector-Specific Skills

Sector-specific skills, including those relevant to the battery and automotive sectors, can be described using ESCO-based skill suggestions or free-text entries. However, there is **no sector-specific validation or benchmarking**.

Language

The platform is available in **31 European languages**, supporting multilingual CV creation and cross-border mobility.

Feedback to User

Europass CV Online provides structural and presentation-oriented feedback.

The platform supports users through:

- guided prompts and completeness indicators when filling in profile sections;
- structured presentation of skills, qualifications and experience;
- standardised formats aligned with European reference frameworks.

This feedback supports self-reflection and transparency, but does not include diagnostic feedback on competence gaps or any form of skills assessment.

Mass Reporting for Institutions

Europass CV Online is an **individual-oriented tool** and does not provide aggregated reporting functionalities for institutions.

Frequency of Updates

The platform is updated **continuously at EU level**, including:

- functional improvements,
- template updates,
- alignment with updates to ESCO and Europass infrastructure.

Associated Courses / Curricula

There is **no direct linkage** to specific courses or curricula.

Indirect links exist through integration with Europass learning opportunity listings and EURES job portals.

Certification

The tool does **not issue certificates**.

It may reference certificates, qualifications and Open Badges uploaded or linked by the user.

Data Privacy & Security

Data protection and privacy standards are **high**, in line with GDPR requirements. Users retain control over data visibility, sharing links and document access.

Integration Capability

Europass CV Online demonstrates **strong integration capability at European level**, notably with:

- ESCO,
- Europass profiles and document library,
- EURES employment services,
- Open Badges (as referenced credentials).

Integration with national validation systems or sector-specific assessment tools is **limited**.

Overall Advantages and Disadvantages

Advantages

- High European recognition and institutional acceptance
- Free, multilingual, and accessible tool
- Strong alignment with European reference frameworks (ESCO, EQF context)
- Enables individuals and institutions to present skills using a shared European format while retaining autonomy over validation and certification processes

Disadvantages

- Relies entirely on self-declared information
- No skills testing, validation, or certification
- Limited suitability for regulated or highly technical professions
- Generic templates may not meet all labour market expectations

4.5.3 Skills Hub - Automotive Skills Alliance (ASA)

Focus

The **Skills Hub**, developed under the **Automotive Skills Alliance (ASA)**, is a European digital tool designed to support **upskilling and reskilling across the automotive-mobility ecosystem**. Its primary focus is to function as a **sector-specific training catalogue and competence mapping platform**, connecting learning offers with shared reference definitions of job roles and competence concepts.

Within the Skills Hub, the **ASA Academy** provides structured learning pathways that group courses into coherent sequences aligned with sectoral skills needs. The platform supports visibility, transparency and coherence of training provision, rather than acting as a standalone assessment or validation system.

Scope

The Skills Hub has a **European scope**, addressing the automotive and mobility ecosystem across EU Member States and associated countries. It aggregates training offers from multiple providers and supports thematic areas related to electrification, digitalisation, sustainability, automation and other transition-driven competence needs.

The tool is sector-specific by design and complements broader European instruments such as Europass and ESCO by focusing on automotive-mobility skills.

Target Group

The Skills Hub targets multiple stakeholder groups, including:

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- individual learners seeking sector-relevant upskilling and reskilling opportunities;
- companies and employers aiming to develop workforce competences;
- training and education providers contributing mapped courses;
- intermediary organisations, social partners and policymakers supporting skills strategies.

The platform is relevant across qualification levels and occupational profiles within the automotive-mobility ecosystem.

Assessment Type

The Skills Hub does **not conduct independent skills assessment or validation**.

Assessment occurs at the level of:

- individual courses offered by training providers, and
- associated micro-credentials or certificates issued by those providers.

The Skills Hub itself functions as an **enabling and structuring tool**, not as an assessor.

Assessment Method

The platform supports assessment processes **indirectly** by:

- mapping courses and their learning outcomes to shared competence concepts and job role references;
- enabling structured classification of training offers;
- linking learning activities to micro-credentials where applicable.

Actual assessment methods (e.g. quizzes, exams, assignments, practical evaluation) are defined and executed by course providers, often through associated learning management systems (such as the ASA learning platform).

Cost of Assessment

Access to the Skills Hub platform is generally **free of charge** for users.

Any costs related to:

- course participation,
- assessment,
- certification or micro-credential issuance

are determined by the individual training providers and not by the Skills Hub itself.

Testing Duration

Testing duration depends on the structure and requirements of individual courses delivered through associated platforms. Course-specific information is provided within the Skills Hub listings.

Profiles Covered

The Skills Hub supports **sector-relevant training profiles** linked to automotive-mobility job roles and competence areas. It does not define formal occupational standards but references shared job role structures used within ASA-related initiatives.

Profiles are descriptive and facilitative rather than regulatory.

EQF Levels

The Skills Hub does **not automatically assign EQF levels**.

EQF alignment may be indicated where:

- courses are linked to nationally or sectorally recognised qualifications, or
- providers explicitly reference EQF levels in their learning outcomes.

Such alignment is dependent on provider practice rather than on a platform-level mechanism.

Competencies Evaluated

The platform does **not evaluate competencies directly**.

It supports documentation and categorisation of competencies by enabling:

- mapping of learning outcomes to competence concepts;
- association of courses with defined skills areas.

Competence evaluation is carried out externally by training providers.

Actual / Emerging Skills

The Skills Hub actively reflects **both current and emerging skills needs** in the automotive-mobility sector. Thematic areas and learning paths address topics such as electrification, digital systems, sustainability, cybersecurity and automation, which are central to the green and digital transitions.

Updates depend on provider contributions and ongoing ASA initiatives.

Sector-Specific Skills

Sector specificity is a core strength of the Skills Hub. All training offers and competence mappings are oriented towards automotive-mobility-related skills, including technical, digital and transversal competences relevant to the sector.

Language

The Skills Hub platform operates primarily in English. Training offers may be available in additional languages depending on provider's origin and delivery format.

Feedback to User

The Skills Hub provides **orientation and progress-related feedback** at learning-path level.

Based on user input (such as selected job role, learning interests and self-declared information), the platform suggests **relevant learning paths** structured by the ASA Academy. Users can follow their progress along these learning paths, tracking course completion and pathway advancement through the associated learning platforms.

This feedback supports learning guidance and motivation but does not constitute skills assessment or competence validation.

Mass Reporting for Institutions

The Skills Hub provides visibility over the training catalogue and mapped competence areas but does **not offer advanced mass reporting or analytics dashboards** for institutions. Any aggregated reporting depends on backend systems or provider-specific tools.

Frequency of Updates

The platform is updated **on a continuous basis** as new courses are added, learning paths refined and competence mappings extended. The Skills Hub builds on earlier European projects (notably DRIVES) and remains under active development within the ASA ecosystem.

Associated Courses / Curricula

The Skills Hub hosts and links to a wide range of courses, including MOOCs and modular learning units, delivered through associated learning platforms. The **ASA Academy** structures selected offers into guided learning paths to support coherent skills development.

Certification

The Skills Hub does **not issue certificates**.

Certification and micro-credentials are issued by training providers upon successful completion of courses and assessments and may be referenced within the Skills Hub listings.

Data Privacy & Security

Data privacy and security are governed by the policies of the platform and associated

learning environments. Personal data processing and user accounts are managed in compliance with applicable data protection regulations.

Integration Capability

The Skills Hub demonstrates **moderate to high integration capability** by:

- linking training provision with shared competence and job role references;
- supporting micro-credential visibility;
- aligning conceptually with European instruments such as ESCO and Europass.

However, integration with national validation systems and formal qualification registries remains limited.

Overall Advantages and Disadvantages

Advantages

- Sector-focused European training catalogue supporting upskilling and reskilling
- Structured competence mapping increases transparency and coherence
- ASA Academy enables guided learning pathways
- Allows external providers to retain autonomy over assessment, feedback and certification, with interoperability based on shared mapping and referencing mechanisms
- Free access and broad European relevance

Disadvantages

- No platform-level assessment or validation
- EQF alignment is not systematic
- Limited institutional reporting and analytics

4.6 Credential Infrastructure and Trust Frameworks

Credential infrastructure tools enable the secure issuance, storage, sharing, and verification of learning credentials. They support trust and interoperability across systems but do not perform skills assessment or validation themselves.

4.6.1 European Learning Model (ELM) and European Digital Credentials Infrastructure (EDC)

Focus

The European Learning Model (ELM) and the European Digital Credentials

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Infrastructure (EDC) together constitute a **European interoperability and trust framework for learning credentials**.

The ELM defines a **common European data model** to describe learning achievements, qualifications, micro-credentials and associated metadata in a structured and machine-readable way. The EDC provides the **digital infrastructure** that operationalises this model, enabling the creation, issuance, storage, sharing and verification of digital learning credentials (see Figure 7).

Their combined focus is **credential transparency, interoperability and trust**, rather than skills assessment or validation of competences.



Figure 7 - European Digital Credential Flow (ELM/EDC)

Scope

The scope of ELM and EDC is **pan-European**. They are designed to support all forms of learning across the lifelong learning continuum, including formal, non-formal and informal learning, and across all sectors of the economy.

The infrastructure is embedded in the **Europass ecosystem** but is designed to allow interoperability with external systems, wallets and credential viewers that comply with the ELM specifications.

Target Group

The main target groups include:

- education and training providers issuing credentials;
- awarding bodies and competent authorities;
- learners and workers receiving and sharing credentials;
- employers and institutions verifying credentials;
- system developers integrating credential exchange and verification functionalities.

Assessment Type

ELM and EDC do **not perform skills assessment**.

They support **credential-based validation**, meaning the verification of:

- credential authenticity,
- issuer identity,

- integrity of credential content.

Assessment of learning outcomes remains the responsibility of issuing organisations.

Assessment Method

No assessment method is implemented at the platform level.

The infrastructure supports:

- digitally signed credentials issued by authorised organisations;
- verification through cryptographic seals and trusted issuer registries;
- machine-readable credential data based on the ELM schema.

This allows third parties to verify that a credential is genuine and unaltered, but not to reassess the learner's competences.

Cost of Assessment

There is **no cost to learners** for receiving, storing or sharing digital credentials through the Europass infrastructure.

Issuers may incur implementation or integration costs depending on their technical setup.

Testing Duration

ELM and EDC do not involve testing or time-bound assessments.

Profiles Covered

Profiles are **credential-based**, not occupational.

ELM supports the description of:

- qualifications,
- certificates,
- diplomas,
- micro-credentials,
- learning achievements and entitlements.

Profiles are defined by the issuing organisation.

EQF Levels

ELM and EDC do **not assign EQF levels automatically**.

EQF levels may be included as metadata in a credential **if and only if** the issuing organisation has formally referenced the qualification or learning outcome to an EQF/NQF level.

Competencies Evaluated

No competencies are evaluated by the infrastructure itself.

Competence descriptions may be embedded within credentials as structured data, depending on issuer practice and alignment with reference frameworks such as ESCO or DigComp.

Actual / Emerging Skills

ELM is designed to be **future-proof and extensible**, allowing new types of learning achievements and skill descriptions to be incorporated as labour market needs evolve.

However, the infrastructure does not identify or label emerging skills on its own.

Sector-Specific Skills

Sector-specific skills can be represented **indirectly**, through credentials issued by sectoral bodies or training providers. ELM provides the structure, but sector relevance depends entirely on issuer design.

Language

ELM and EDC support **multilingual credential representation**, enabling credentials to be issued and viewed in multiple European languages.

Feedback to User

The infrastructure provides **credential-related feedback**, not learning or competence feedback.

Users can:

- view issued credentials,
- verify their authenticity,
- manage storage and sharing permissions,
- receive confirmation of successful issuance.

No diagnostic, orientative, or progress feedback is provided.

Mass Reporting for Institutions

While issuers can manage and track issued credentials, EDC is not designed as a reporting or analytics platform for institutional performance or skills monitoring.

Frequency of Updates

The European Learning Model and EDC are under **continuous development and maintenance** at European level, with updates reflecting policy evolution, stakeholder

feedback and technical requirements.

Associated Courses / Curricula

ELM and EDC are **content-agnostic**.

They can be used to issue credentials linked to any course, curriculum or learning pathway, provided the issuer adopts the ELM structure.

Certification

ELM and EDC do **not certify learners directly**.

They enable the **digital issuance and verification of certificates** created by authorised issuing bodies.

Data Privacy & Security

Data protection and security are **high** and compliant with GDPR.

Credentials are digitally sealed, and users retain control over access, sharing and visibility of their credentials.

Integration Capability

ELM and EDC demonstrate **very high integration capability**. They:

- provide a common European data model for credentials;
- enable interoperability between national, sectoral and institutional systems;
- support decentralised issuance and verification models;
- align conceptually with Europass, ESCO and other European skills instruments.

Overall Advantages and Disadvantages

Advantages

- Enables trusted, verifiable and portable digital credentials
- Strong European interoperability through a shared data model
- Supports decentralised assessment and certification models
- Compatible with diverse providers, sectors and national systems

Disadvantages

- Does not assess or validate skills itself
- Effectiveness depends on issuer adoption and credential quality
- EQF and skills metadata inclusion is not systematic

5. Analysis of existing tools for self-assessment and validation of skills

5.1 Purpose and Scope of the Analysis

This chapter presents a structured analysis of competence frameworks, self-assessment tools, and validation models relevant to the battery sector, with the objective of identifying gaps, enabling factors, and implications for the development of a coherent European approach to skills validation and recognition.

The scope of the analysis is intentionally system-level and sector-oriented. Rather than evaluating individual frameworks or tools in isolation, the chapter examines how existing elements interact across the skills lifecycle — from competence definition and assessment to validation, recognition, and portability. Particular attention is given to the extent to which current approaches support emerging job roles, transversal digital and green competences, and cross-border transparency within the battery value chain.

The analysis focuses on initiatives operating at European, national, and sectoral levels, including both transversal and sector-specific instruments. While the battery sector is used as the primary reference context, the analytical approach is designed to be sufficiently generic to inform broader discussions on skills validation in other industrial domains.

The analytical approach and methodological framework underpinning this chapter are described in Chapter 2.

5.2 Comparative Analysis of Competence Frameworks

This section provides a structured overview of the competence frameworks identified as relevant to skills development in the battery sector. The analysis focuses on both sector-specific and transversal frameworks operating at European and national levels, examining their scope, coverage and positioning within the broader skills ecosystem.

The objective of this section is not to assess the effectiveness of these frameworks in terms of validation or recognition, but to establish a **clear baseline of existing reference structures** used to describe competences, job roles and learning outcomes. By mapping these frameworks against a common set of descriptors, the section lays the foundation for understanding how competences are currently conceptualised across initiatives and where complementarities or overlaps exist.

5.2.1 Sectoral vs National vs Transversal Frameworks

The competence frameworks mapped in Chapter 3 can be grouped into three main categories that fulfil distinct functions within the European skills ecosystem: **sectoral competence frameworks, national qualifications and validation frameworks, and cross-cutting European reference frameworks**. Although these categories

partially overlap, they operate at different levels of specificity and address different dimensions of skills development, recognition and transparency.

Sectoral competence frameworks are primarily designed to respond to **industry-specific skills needs**. In the context of the battery sector, they typically provide the strongest alignment with **technical competences, occupational profiles and value-chain-related activities**. Their focus on concrete job roles and operational skills enables close alignment with labour market demand. However, their level of formal integration with national qualification systems and EQF-referenced structures varies, depending on governance models and implementation contexts.

National qualifications and validation frameworks operate at a different level, providing the **formal structures for recognition, certification, and progression** within national education and training systems. These frameworks are generally cross-sectoral and ensure strong alignment with national qualification frameworks and the EQF. While they can incorporate battery-related job roles and competences, the degree of sectoral specificity and responsiveness to emerging skills depends on national update cycles, institutional arrangements, and stakeholder involvement.

Cross-cutting European reference frameworks, such as DigComp and GreenComp, serve a complementary function. They define **transversal competences** relevant across sectors, occupations, and levels of learning, particularly in relation to the digital and green transitions. These frameworks provide a shared European language and conceptual coherence, supporting interoperability and policy alignment. However, they do not define job roles, occupational standards, or formal validation mechanisms and are therefore not designed to operate as standalone instruments for skills recognition.

The qualitative comparison in Table 1 highlights these functional differences across five analytical dimensions.

Table 2 - Qualitative comparison of framework categories

Framework category	Battery value-chain relevance	Job roles & technical skills	Transversal competences	EQF alignment	Integration capability
Sectoral frameworks	High	High	Medium	Medium	Medium
National frameworks	Medium	Medium	Medium	High	Medium
Cross-cutting EU frameworks	Medium	Low	High	Low	High

This comparison illustrates that no single category of framework addresses all dimensions of competence development and recognition. Sectoral frameworks prioritise occupational relevance, national frameworks provide formal recognition structures, and cross-cutting European frameworks ensure coherence for transversal competences and interoperability. Together, these categories form a **complementary but fragmented landscape**, which underlines the importance of analysing how different frameworks interact across the battery value chain and how transversal competences are integrated into sector-specific and national systems. These aspects are examined in the following sections.

5.2.2 Coverage of the Battery Value Chain and Job Roles

The analysis of the mapped competence frameworks reveals **uneven coverage across the battery value chain**, both in terms of activities and associated job roles. While certain phases of the value chain are relatively well represented, others remain only partially addressed or are emerging areas with limited formalisation.

Downstream activities, particularly those related to **battery integration, operation, maintenance, and repair**, are the most consistently covered across frameworks.

Sectoral competence frameworks and several national qualification systems include job roles and skills linked to electric and hybrid vehicle maintenance, high-voltage safety, diagnostics and system servicing. These areas benefit from clearer occupational definitions and more mature training and validation pathways, reflecting earlier market uptake and regulatory requirements.

Coverage of **midstream activities**, such as **cell, module and battery pack manufacturing**, is more fragmented. Some sectoral frameworks and national initiatives address manufacturing-related competences, but often at a high level or within broader manufacturing occupations rather than through dedicated battery-specific job profiles. Skills related to quality control, testing, automation and production optimisation are frequently present, yet not always explicitly framed within a battery value-chain context.

The **upstream phase**, including **raw materials processing and component preparation**, shows limited representation in the analysed frameworks. Where present, competences are usually embedded within generic chemical, materials or process engineering profiles, without explicit reference to battery applications. As a result, battery-specific upstream job roles and skills are rarely articulated in a systematic manner.

Similarly, **end-of-life activities**, such as **second-life applications, reuse and recycling of batteries**, are among the least covered areas. Although sustainability and circular economy principles are increasingly referenced at a conceptual level, concrete occupational profiles and competence sets related to battery recycling, repurposing and lifecycle management remain underdeveloped in most frameworks.

In addition to formal sectoral and national frameworks, **operational job role and skills definitions developed within European Blueprint projects** contribute to addressing emerging competence needs along the battery value chain. In particular, the **skills cards associated with the Automotive Skills Hub and developed under the ALBATTIS project** provide detailed descriptions of battery-related job roles and competences, notably in manufacturing, integration and recycling activities. While these skills cards do not constitute a formal competence framework or validation system, they enhance the visibility and structuring of emerging job roles and are currently being reused in the **VOLTAGE project** for the design of new training programmes.

Across the value chain, the degree of job role definition varies significantly by framework type. Sectoral frameworks tend to offer more detailed descriptions of operational roles, while national frameworks provide formal recognition structures but often rely on broader occupational classifications. Cross-cutting European reference frameworks do not address job roles directly, but provide transversal competences that are relevant across all phases of the value chain.

Overall, the mapping indicates that **job roles and skills coverage are strongest in mature, downstream segments of the battery value chain**, while upstream, manufacturing-specialised and end-of-life segments remain comparatively underrepresented. This uneven distribution reflects both the current maturity of the sector and differences in how frameworks prioritise occupational specificity, technical depth and formal recognition.

5.2.3 Integration of Transversal Competences

In addition to technical and occupational skills, the analysed competence frameworks differ significantly in how they address **transversal competences**, particularly those related to the **digital and green transitions**. These competences are increasingly recognised as essential across all phases of the battery value chain, yet their integration into existing frameworks remains uneven.

Cross-cutting European reference frameworks, such as DigComp and GreenComp, provide the most explicit and structured definitions of transversal competences. They establish comprehensive conceptual models for digital and sustainability-related competences that are applicable across sectors, occupations and levels of learning. However, these frameworks do not specify how transversal competences should be operationalised within sector-specific job roles or linked to formal validation mechanisms.

Within **sectoral competence frameworks**, transversal competences are often addressed implicitly rather than through explicit reference to European frameworks. Digital skills related to automation, diagnostics, data handling and safety are frequently embedded within technical competence descriptions, while sustainability-related aspects are commonly framed in terms of compliance, environmental awareness or safety requirements. Explicit alignment with DigComp or GreenComp is rare, and transversal competences are seldom articulated as standalone or assessable components.

National qualifications and validation frameworks occupy an intermediate position. While they increasingly acknowledge transversal competences within learning outcomes and qualification descriptors, integration practices vary by country and sector. Digital competences are more commonly incorporated, often linked to broader national digital skills strategies, whereas sustainability competences are typically embedded at a general or conceptual level rather than translated into concrete occupational requirements.

Across all framework categories, transversal competences tend to be **treated as complementary rather than integral** to occupational profiles. This results in limited visibility of digital and sustainability competences at job-role level and reduces their potential for systematic assessment and recognition. Moreover, the lack of explicit mapping between transversal frameworks and sectoral or national competence models hinders comparability and interoperability across systems.

In addition to formal competence frameworks, operational artefacts such as the job role and skills cards developed under the ALBATTs Blueprint project explicitly categorise technical, digital and sustainability-related competences for battery-related occupations. While these skills cards enhance the visibility and structuring of transversal competences at

job-role level, they do not explicitly reference or map these competences to European transversal frameworks such as DigComp or GreenComp. As a result, transversal competences are identified and grouped, but not systematically aligned with shared European reference models.

Overall, the analysis indicates that while transversal competences are widely acknowledged in principle, their **systematic integration into sector-specific and nationally validated frameworks remains limited**. This gap affects the ability of existing frameworks to fully reflect the skill sets required for the combined digital and green transitions of the battery sector.

5.3 Comparative Analysis of Tools

The tools mapped in Chapter 4 fulfil **distinct and complementary functions** within the European skills ecosystem. Rather than operating as a single integrated system, they address different stages of the skills lifecycle, ranging from skills measurement and self-reflection to competence referencing, learning guidance and credential verification. This section analyses these tools comparatively, based on their **functional role, type of feedback and assessment, and capacity to support skills validation and recognition**.

5.3.1 Functional Coverage of the Skills Ecosystem

From a functional perspective, the analysed tools can be grouped into five main categories: **monitoring and benchmarking tools, self-assessment and reflection tools, standardised digital competence tests, skills reference and learning pathway tools, and credential infrastructure and trust frameworks**.

Monitoring and benchmarking tools, such as the Digital Skills Index (DSI 2.0), operate at **aggregate level**, providing population-based indicators that support policy development and cross-country comparison. While they offer valuable insights into overall skills trends, they do not interact directly with individuals nor support skills validation or recognition at job-role level.

Self-assessment and reflection tools, including SELFIE, DigSAT and MyDigiSkills, support **awareness and orientation** at individual or organisational level. These tools rely primarily on self-reported information and provide orientative or diagnostic feedback. They play an important role in initiating learning processes but are not designed to support formal assessment, validation or certification.

Standardised digital competence tests, such as the IT Fitness Test, introduce a higher degree of objectivity by using predefined assessment items and score-based outputs. These tools enable baseline measurement and benchmarking at individual level, but they remain **auto-administered tests** and do not constitute formal validation mechanisms or lead to recognised credentials.

Skills reference and learning pathway tools, including ESCO, Europass and the Skills Hub

of the Automotive Skills Alliance, focus on **skills transparency, mapping and navigation**. They enable consistent description of competences, alignment with job profiles and connection to learning opportunities. However, they do not perform skills assessment or validation themselves, and their effectiveness depends on integration with external training and assessment providers.

Finally, credential infrastructure and trust frameworks, such as the European Learning Model (ELM) and the European Digital Credentials Infrastructure (EDC), provide the technical means to **issue, store, share and verify learning credentials**. These tools support trust and interoperability across systems, but they do not assess competences or determine learning outcomes, which remain the responsibility of issuing organisations.

To support a synthetic comparison of these functional roles, Table 2 provides a **qualitative overview of tool categories** across key dimensions of the skills lifecycle.

Table 3 - Qualitative comparison of tool categories

Tool category	Individual skills assessment	Learning orientation & guidance	Validation & certification support	Credentialing & verification	Interoperability & integration readiness
Monitoring & benchmarking tools	Low	Low	None	None	Medium
Self-assessment & reflection tools	Medium	Medium	None	None	Low
Standardised competence tests	Medium	Low	None	None	Low
Skills reference & learning pathway tools	None	High	Low	None	High
Credential infrastructure & trust frameworks	None	None	Medium	High	High

Note: The comparison is qualitative and reflects the primary functional role of each tool category rather than individual implementations.

The table illustrates that **no single category of tools covers the full skills lifecycle**, from assessment to validation and credentialing. Instead, each category addresses a specific function, with limited overlap between assessment-oriented tools and those supporting credential issuance and verification.

5.3.2 Assessment, Validation and Credentialing

A comparative analysis of assessment and validation functions highlights a **clear separation of roles** among the analysed tools. Assessment activities are primarily concentrated in self-assessment tools and standardised tests, while validation and certification functions are largely external to the tools themselves.

Self-assessment tools provide **reflective or diagnostic feedback** but do not produce

validated results. Standardised tests offer score-based outputs, improving comparability and objectivity, yet they do not lead to recognised qualifications. Validation and certification processes are typically managed by **external institutions**, such as awarding bodies, training providers or national authorities, rather than being embedded within the tools.

Credentialing is addressed primarily through the ELM/EDC infrastructure, which enables the **verification of credential authenticity and issuer trust**, but does not validate skills independently. As a result, no single tool provides an end-to-end pathway from skills identification and assessment to formal validation and credential issuance.

5.3.3 Interoperability and Integration Readiness

Interoperability emerges as a key differentiating factor among the analysed tools. Tools such as ESCO, Europass and ELM/EDC demonstrate **high integration potential**, as they are explicitly designed to support interoperability through shared data models, reference frameworks and European standards.

Other tools, particularly self-assessment and testing instruments, tend to operate as **standalone applications** with limited integration into broader skills ecosystems. While they can inform learning and training decisions, their outputs are not systematically linked to credentialing or validation infrastructures.

Overall, the comparative analysis shows that existing tools collectively cover many individual functions required within a skills ecosystem, but **integration across these functions remains limited**. The lack of systematic linkage between assessment, learning pathways, validation and credentialing reduce the ability of current tools to support coherent and scalable skills recognition processes, particularly in complex and rapidly evolving sectors such as batteries.

5.4 Gap Analysis

Building on the mapping of competence frameworks (Section 5.2) and the analysis of existing self-assessment and validation tools (Section 5.3), this section examines the **structural gaps and limitations** that characterise the current European landscape for skills validation and recognition in the battery sector. The focus is on identifying systemic issues rather than deficiencies of individual frameworks or tools.

The analysed national cases such as Finland and Germany further strengthens this assessment, illustrating the structural diversity of validation architectures across Europe. While some systems operate through centrally coordinated, competence-based qualification models, others rely on decentralised, industry-driven and project-based ecosystems, reinforcing the systemic heterogeneity identified in this analysis.

The gap analysis adopts a lifecycle perspective, considering how competences are defined, assessed, validated, recognised and made portable across contexts. By analysing the interaction — or lack thereof — between frameworks, tools, sector-level platforms and

national systems, this section highlights the key challenges that hinder coherence, interoperability and sector-wide applicability. The findings of this analysis provide the analytical basis for identifying enabling factors and design implications in the subsequent sections.

5.4.1 Structural Gaps in the European Skills Ecosystem

The comparative analysis of competence frameworks and tools highlights a set of **structural gaps** that characterise the current European skills ecosystem for the battery sector. These gaps do not stem from a lack of initiatives, but rather from the way existing elements are **distributed, specialised and insufficiently connected**.

A first structural gap concerns the **fragmentation between competence frameworks operating at different levels**. Sectoral frameworks, national qualification systems and cross-cutting European reference frameworks coexist, each addressing specific dimensions of skills development and recognition. However, these frameworks are rarely aligned in a systematic manner. Sectoral frameworks prioritise occupational relevance, national frameworks focus on formal recognition and progression, and transversal European frameworks address digital and sustainability competences, but there is no overarching mechanism that consistently links these layers across countries and sectors.

The fragmentation of the current skills ecosystem is illustrated in Figure 8, which highlights the separation between competence frameworks, skills assessment and learning tools, and validation and credentialing mechanisms.

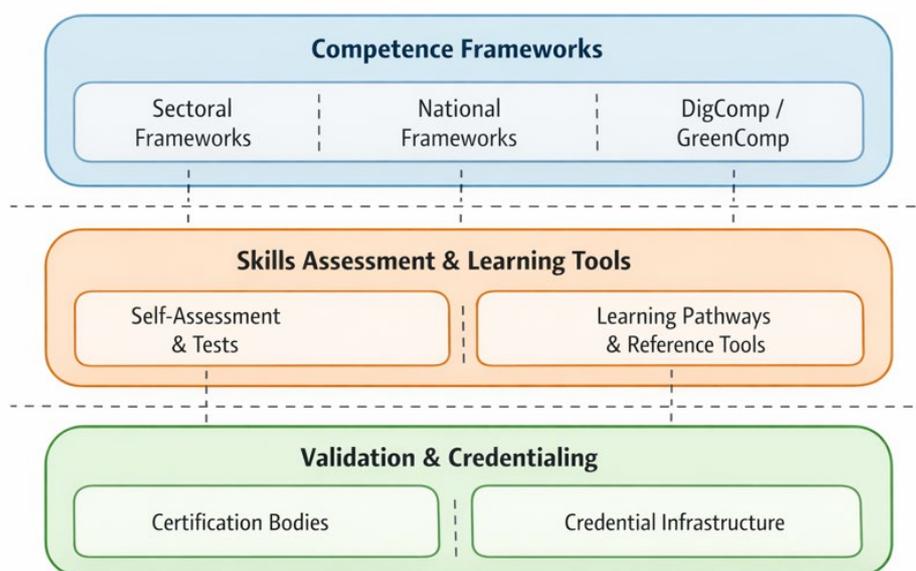


Figure 8 - Structural fragmentation of the European skills ecosystem.

As shown in the figure, competence frameworks, assessment and learning tools, and validation and credentialing mechanisms operate largely in parallel, with limited systematic linkage between layers. While each layer fulfils a specific function, the absence of structured connections results in fragmented skills pathways rather than integrated end-to-end processes. This fragmentation is particularly visible in the transition from skills assessment to formal validation and recognised credentials.

A second gap relates to the **separation between skills identification, assessment, validation and credentialing**. As shown in the analysis of tools, these functions are distributed across different instruments that operate largely independently. Self-assessment and testing tools support skills identification and awareness, learning platforms support training delivery, and credential infrastructures enable verification of learning outcomes. However, there is limited continuity between these stages, resulting in fragmented skills pathways rather than integrated end-to-end processes.

The analysis also reveals a **disconnect between framework-level definitions and operational implementation**. While competence frameworks define skills, roles or reference models at a conceptual level, their translation into assessment practices, validation procedures and recognised credentials is often left to local or national actors. This creates variability in interpretation and limits comparability across systems, particularly in a cross-border context.

Another structural gap concerns the **lack of a common European mechanism for sector-specific skills validation**. Although national frameworks provide EQF-referenced validation structures, these are generally designed for broad occupational categories and are not consistently aligned with emerging sector-specific competence needs, such as those related to batteries. As a result, skills acquired through non-formal or project-based initiatives face challenges in achieving formal recognition across national boundaries.

Finally, the current ecosystem exhibits **limited interoperability across tools and frameworks**, despite the existence of European reference models and digital infrastructures. While some tools are designed with interoperability in mind, most assessment and learning instruments remain standalone solutions. The absence of systematic data exchange and alignment mechanisms reduces the potential of existing tools to operate as part of a coherent European skills validation ecosystem.

Taken together, these structural gaps indicate that the main challenge lies not in the absence of frameworks or tools, but in the **lack of guidance and integration across levels, functions and systems**. Addressing these gaps requires mechanisms that can connect sectoral competence definitions, transversal reference frameworks, assessment practices and credentialing infrastructures in a coherent and scalable way.

This fragmentation is particularly visible when comparing nationally integrated models, such as Finland's legally embedded competence-based validation system, with more decentralised and regionally differentiated ecosystems, such as Germany's battery-related training landscape. These contrasts demonstrate that fragmentation is not only cross-border but also structural in nature.

5.4.2 Sector-Specific Gaps for the Battery Ecosystem

Beyond the structural gaps identified at system level, the analysis reveals a set of **sector-specific gaps** affecting the battery ecosystem. These gaps are primarily related to **uneven coverage of the battery value chain**, differences in job role definition maturity, and limited readiness for skills validation in emerging segments of the sector.

As discussed in Section 5.3.2, existing competence frameworks tend to focus on **more mature and downstream segments** of the battery value chain, while upstream, manufacturing-specialised and end-of-life activities remain comparatively underrepresented. This imbalance reflects both the historical development of the sector and the varying capacity of frameworks to adapt to emerging industrial needs.

To illustrate these differences in a synthetic manner, Table 3 provides a **qualitative overview of framework coverage across key segments of the battery value chain**, considering three analytical dimensions: competence framework coverage, job role definition and validation readiness.

Table 4 - Qualitative coverage of the battery value chain

Battery value chain segment	Framework coverage	Job role definition	Validation readiness
Upstream (raw materials, processing)	Low	Low	Low
Midstream (cell, module and pack manufacturing)	Medium	Medium	Low
Downstream (integration, operation, maintenance)	High	High	Medium
End-of-life (second life, reuse, recycling)	Low	Low	Low

Note: The assessment is qualitative and reflects the typical level of coverage observed across the mapped frameworks and tools.

The table highlights that **downstream activities** benefit from the highest level of framework maturity, including clearer job role definitions and more established validation pathways. This is largely driven by regulatory requirements, earlier market uptake and the availability of formal training and certification mechanisms related to vehicle operation and maintenance.

In contrast, **midstream manufacturing activities** show partial coverage. While certain competences related to production, quality control and automation are addressed, they are often embedded within broader manufacturing occupations rather than articulated through battery-specific job profiles. Validation readiness in this segment remains limited, particularly for skills acquired through non-formal or project-based learning.

The most significant gaps are observed in the **upstream** and **end-of-life** segments of the battery value chain. In upstream activities, battery-specific competences are typically subsumed under generic engineering or materials science profiles, with little explicit recognition of battery-related applications. End-of-life activities, including second-life use, reuse and recycling, remain largely underdeveloped in terms of formal job role definition and validation, despite their strategic importance for sustainability and circularity.

Although operational artefacts such as the **ALBATTTS skills cards** contribute to improving visibility of job roles and competences in some emerging areas, their impact on validation readiness remains limited in the absence of systematic alignment with national qualification frameworks and European reference models.

Overall, the sector-specific analysis indicates that the battery ecosystem is characterised by **asymmetrical development across the value chain**, with significant implications for skills recognition, workforce mobility and the ability to support the green transition through validated competences.

5.4.3 Gaps in the Integration of Transversal Competences

Transversal competences related to the **digital and green transitions** are widely recognised as critical enablers for the development of the battery ecosystem. However, the analysis reveals a significant gap in the **systematic integration of these competences** within sector-specific and nationally validated competence frameworks.

European transversal competence frameworks, notably **DigComp** and **GreenComp**, provide comprehensive reference models for digital and sustainability-related competences across sectors and occupations. These frameworks establish a common European language and conceptual coherence, but they are not directly linked to occupational profiles, job roles or validation mechanisms in the battery sector.

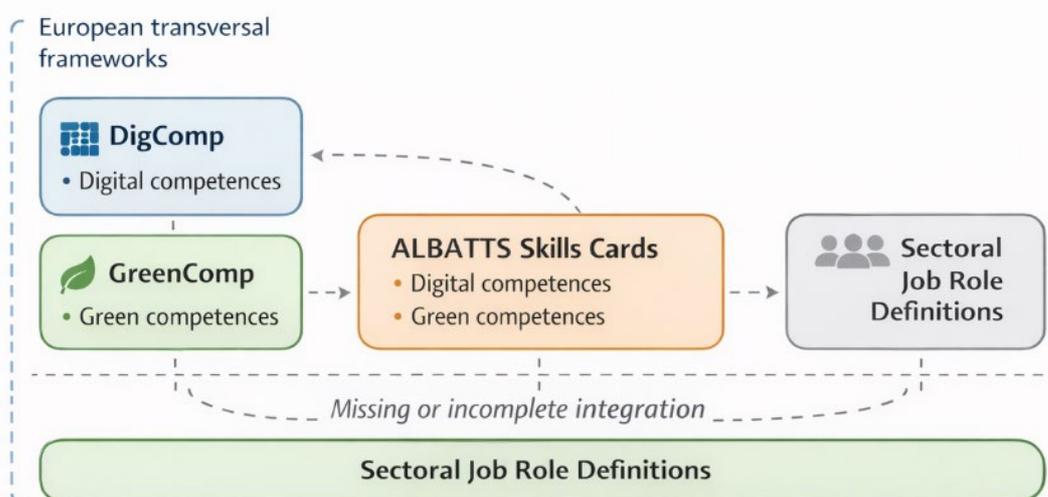


Figure 9 - Gaps in the integration of transversal competences. The diagram highlights missing or incomplete connections between European transversal frameworks (DigComp and GreenComp), sectoral job role definitions and operational artefacts such as the ALBATTs skills cards.

As illustrated in **Figure 9**, transversal competence frameworks operate largely in parallel to sector-specific competence definitions. Sectoral frameworks and job role descriptions rarely reference DigComp or GreenComp explicitly. Instead, transversal competences are typically embedded implicitly within technical competence descriptions or addressed at a general level. This results in limited visibility of digital and green competences as distinct, assessable and transferable skill sets.

Operational artefacts developed within European initiatives, such as the **ALBATTs skills cards**, partially address this gap by explicitly identifying and categorising digital and green competences alongside technical skills at job-role level. However, these skills cards do not systematically map transversal competences to DigComp or GreenComp competence areas and proficiency levels. As a result, transversal competences are recognised and grouped, but not aligned with shared European reference models.

The absence of explicit mapping mechanisms creates challenges for **comparability, interoperability and validation**. Without alignment to transversal frameworks, digital and green competences remain difficult to benchmark across countries, sectors and qualification systems. This limits their portability and reduces the potential for consistent

validation and recognition, particularly in cross-border and lifelong learning contexts.

Overall, the analysis indicates that transversal competences are increasingly acknowledged within the battery sector, but their integration remains **fragmented and unsystematic**. Bridging the gap between transversal European frameworks, sector-specific job role definitions and validation mechanisms remains a key challenge for the development of a coherent and future-oriented skills ecosystem.

5.4.4 Validation and Recognition Gaps

The analysis of existing tools and frameworks reveals significant gaps in the **validation and recognition of skills**, particularly when considering sector-specific competences in the battery ecosystem. While multiple tools support skills identification, self-assessment and learning orientation, **formal validation and recognition remain weakly addressed and unevenly distributed** across systems.

A core issue is that the skills lifecycle is currently covered in an **asymmetrical and discontinuous** way: early-stage functions (such as identification and self-assessment) are comparatively well supported, whereas formal assessment, validation and recognised outcomes remain limited. To illustrate this imbalance, Table 4 provides a qualitative overview of how the mapped tools cover key stages of the skills lifecycle.

Table 5 - Skills lifecycle coverage by existing tools (qualitative overview)

Skills lifecycle stage	Coverage by existing tools
Skills identification	High
Self-assessment	High
Learning pathways / guidance	Medium
Formal assessment	Low
Validation	Low
Credentialing and verification	Medium–High

Note: The comparison is qualitative and reflects the typical functional coverage observed across the mapped tool categories.

The table highlights that **skills identification and self-assessment** are relatively well supported through self-assessment tools and standardised tests, while **learning guidance** is partially addressed through skills reference and pathway tools. However, there is limited tool-based coverage of **formal assessment and validation**, which remain largely external to the mapped digital tools. Credentialing and verification are increasingly supported through infrastructures such as ELM/EDC, but the impact of these infrastructures depends on the existence of trusted issuers and recognised assessment processes.

A first gap therefore concerns the **limited availability of formal assessment mechanisms** aligned with sector-specific competence definitions. Most existing tools focus on self-assessment or standardised testing, which provide valuable diagnostic or benchmarking outputs but do not constitute validated evidence of competence. As a result, skills identified through these tools are not systematically recognised by qualification authorities, employers or certification bodies.

A second gap relates to the **externalisation of validation and certification processes**. Validation and certification are typically performed by national authorities, awarding bodies or training providers, rather than being embedded within skills tools themselves. While this separation preserves institutional autonomy, it also creates fragmentation and variability in validation practices, particularly across national borders and sectors. In the absence of shared European validation mechanisms, sector-specific competences often remain confined to national or project-based contexts.

The analysis also highlights a gap between **learning outcomes and recognised credentials**. Although learning pathways and training programmes are increasingly supported by skills reference and guidance tools, the transition from completed learning activities to formally recognised credentials is not systematic. This gap is particularly evident for skills acquired through non-formal and informal learning, including those developed in project-based initiatives or workplace contexts.

Credential infrastructures such as the **European Learning Model (ELM)** and the **European Digital Credentials Infrastructure (EDC)** partially address this challenge by enabling secure issuance, storage and verification of digital credentials. However, these infrastructures do not validate competences themselves and depend on the existence of trusted issuers and recognised assessment processes. In the absence of harmonised validation criteria and sector-specific reference models, the potential of digital credentials remains underexploited.

Finally, the lack of **cross-border recognition mechanisms** represents a further gap. Even where assessment and certification exist at national level, their recognition across countries is not guaranteed. This limits workforce mobility and reduces the effectiveness of skills development initiatives in supporting a European battery value chain.

Overall, the analysis indicates that the main validation and recognition gaps lie not in the absence of tools or infrastructures, but in the **lack of coherent linkage between skills identification, assessment, validation and credentialing**. Addressing these gaps requires mechanisms that can bridge sector-specific competence definitions with trusted validation processes and interoperable credential infrastructures at European level.

5.4.5 SWOT Analysis of the European Battery Skills Validation Ecosystem

To synthesise the findings of the gap analysis presented in Sections 5.5.1 to 5.5.4, a SWOT analysis is used to provide a **concise, system-level overview** of the current European skills validation ecosystem for the battery sector. This analysis reflects structural, sector-specific, transversal and validation-related aspects identified throughout the chapter.

The SWOT analysis does not evaluate individual frameworks or tools, but rather considers the **ecosystem as a whole**, highlighting internal strengths and weaknesses, as well as external opportunities and threats affecting the development of coherent and scalable skills validation mechanisms.

Table 6 - SWOT analysis of the European battery skills validation ecosystem

Strengths	Weaknesses
<ul style="list-style-type: none"> ▪ Existence of multiple mature European competence frameworks and tools ▪ Strong policy alignment with green and digital transitions ▪ Availability of European reference frameworks (DigComp, GreenComp, ESCO) ▪ Emerging digital credential infrastructures (ELM/EDC) ▪ Active sectoral initiatives and project-based competence development 	<ul style="list-style-type: none"> ▪ Fragmentation between sectoral, national and transversal frameworks ▪ Limited integration of transversal competences at job-role level ▪ Uneven coverage of the battery value chain ▪ Lack of end-to-end skills validation pathways ▪ Validation and recognition largely dependent on national systems
Opportunities	Threats
<ul style="list-style-type: none"> ▪ Reuse and alignment of existing sectoral assets and platforms ▪ Increasing adoption of micro-credentials and digital credentials ▪ Sector-level initiatives enabling faster operationalisation ▪ Cross-project reuse and consolidation of skills artefacts ▪ Strengthening interoperability through European digital infrastructures 	<ul style="list-style-type: none"> ▪ Duplication of initiatives and parallel systems ▪ Limited cross-border recognition of sector-specific skills ▪ Slow institutional uptake of new validation approaches ▪ Risk of over-standardisation without sector flexibility ▪ Persistent skills mismatches due to delayed framework updates

The SWOT analysis confirms that the European battery skills ecosystem is characterised by a **strong foundation of frameworks, tools and policy instruments**, but also by significant weaknesses related to fragmentation, uneven coverage and limited validation coherence. At the same time, ongoing sectoral initiatives, digital credential infrastructures and transversal European frameworks represent important opportunities to address these challenges, provided that integration and alignment mechanisms are effectively developed.

5.5 Enablers for a Joint European Validation Framework

Building on the gaps and systemic challenges identified in Section 5.5, this section examines **existing enablers** that can support the development of a more coherent European approach to skills validation and recognition in the battery sector. The focus is on identifying frameworks, platforms and infrastructures that are already in place and that provide the necessary **conceptual, operational and technical foundations** for improved integration, without introducing new systems or proposing implementation solutions.

Figure 10 provides a synthetic overview of how these enablers can be positioned across

different layers of the skills ecosystem.

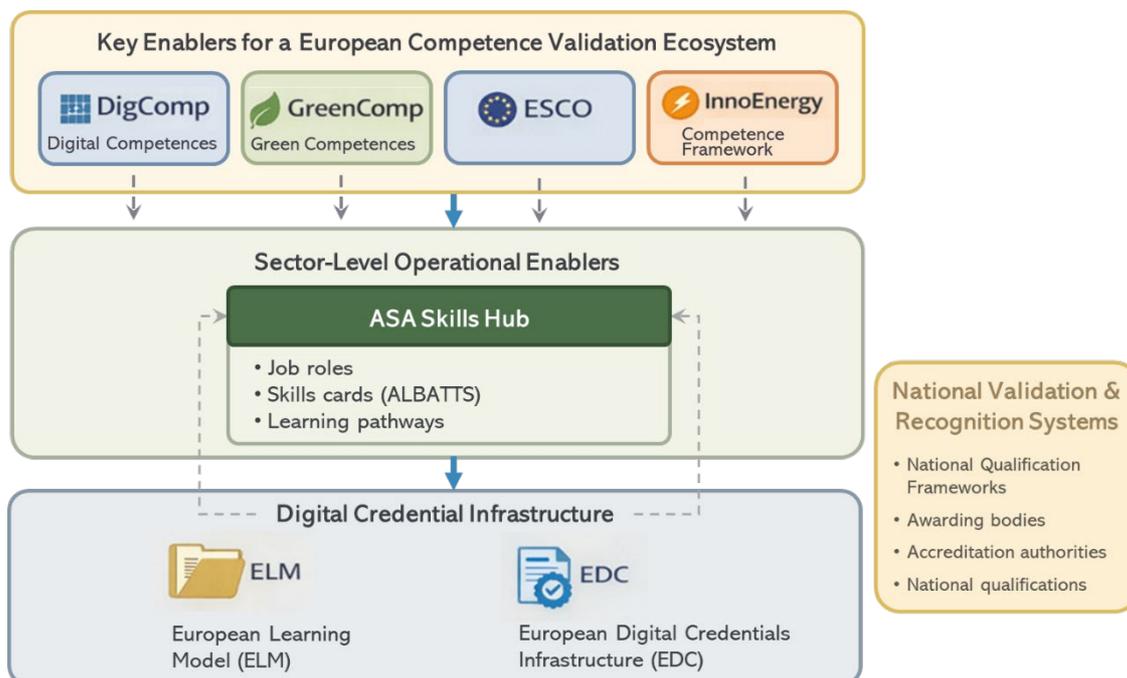


Figure 10 - Enablers for an integrated European battery skills validation ecosystem

As illustrated in the figure, at European level, transversal reference frameworks such as DigComp, GreenComp and ESCO, together with sector-specific initiatives such as the InnoEnergy Competence Framework, establish common reference points for skills and occupations. At sector level, operational platforms such as the ASA Skills Hub translate these references into job roles, skills cards and learning pathways tailored to the battery value chain. In parallel, European digital credential infrastructures, notably the European Learning Model (ELM) and the European Digital Credentials Infrastructure (EDC), provide the technical basis for interoperable and portable credentials. Finally, national validation and recognition systems remain responsible for the formal recognition of skills and learning outcomes, operating according to national rules and procedures.

Together, these elements illustrate that many of the building blocks required for a joint European validation framework already exist. However, they operate at different levels and with varying degrees of connection, highlighting the need for structured approaches to alignment and interoperability, as further explored in the following sections.

The comparative evidence from national frameworks confirms that Europe does not lack robust validation structures. Rather, it demonstrates the coexistence of multiple mature but differently organised systems, underscoring that the challenge lies in interoperability and coordination rather than in the creation of entirely new validation architectures.

5.5.1 European Reference and Interoperability Enablers

The gap analysis presented in Section 5.5 highlighted that fragmentation in the European battery skills ecosystem is not primarily caused by a lack of competence frameworks, but by **insufficient alignment and interoperability across levels and systems**. In this

context, European reference frameworks act as key enablers by providing shared concepts, classifications and reference points that can mitigate fragmentation at content and terminology level.

Transversal competence frameworks such as **DigComp** and **GreenComp** address one of the gaps identified in Section 5.5.3, namely the limited visibility and systematic integration of transversal digital and green competences within sector-specific job role definitions. By offering structured and widely adopted competence models, these frameworks enable transversal skills to be referenced consistently across sectors, even if their operationalisation remains external to the frameworks themselves.

ESCO contributes directly to addressing the interoperability gaps identified in Section 5.5.1. As a common European taxonomy of skills, competences, occupations and qualifications, ESCO supports consistent skills description and mapping across sectoral initiatives and national systems. While it does not perform validation or recognition functions, its role as a reference classification is a prerequisite for reducing semantic fragmentation and enabling cross-system comparability.

Within the battery sector, the **InnoEnergy Competence Framework** responds to the sector-specific coverage gaps identified in Section 5.5.2 by providing a European-level competence reference aligned with the battery value chain. Its contribution lies primarily at content level, supporting a shared understanding of battery-related competences across countries and stakeholders. However, as identified in the gap analysis, it does not address validation, recognition or operational implementation, and therefore requires complementary enablers to translate reference content into practice.

Overall, European reference and interoperability enablers address gaps related to **fragmentation, comparability and transversal competence visibility**, but they do not resolve gaps related to assessment, validation and recognition, which occur at other levels of the ecosystem.

5.5.2 Sector-Level Operational Enablers

Section 5.5 identified a significant gap between competence frameworks and their operational use in skills development and workforce planning, particularly at sector level. While reference frameworks define competences conceptually, their translation into **job roles, skills descriptions and learning pathways** remains uneven across the battery value chain. Sector-level operational enablers play a critical role in addressing this gap.

The **ASA Skills Hub** directly responds to the operational gaps highlighted in Sections 5.5.1 and 5.5.2 by providing a European sector-level environment in which battery-related job roles and competences can be structured and consolidated. By operating closer to industry and training stakeholders, the Skills Hub supports the contextualisation of European reference frameworks within the specific realities of the battery ecosystem.

Operational artefacts such as the **ALBATTs skills cards** contribute to addressing the uneven coverage of the battery value chain identified in Section 5.5.2. By explicitly defining emerging job roles and associated competences, including digital and green skills, these artefacts enhance transparency and consistency across training and curriculum

development activities. Their use in multiple initiatives demonstrates their practical relevance, while also highlighting the absence of systematic validation pathways for such competences.

As identified in Section 5.5.4, sector-level operational enablers do not in themselves resolve validation and recognition gaps. Their primary contribution lies in **structuring competences in an operationally usable form**, thereby creating the necessary preconditions for assessment and validation by external actors. Their effectiveness therefore depends on their ability to interface with both European reference frameworks and national validation and recognition systems.

5.5.3 Bridging Mechanisms Between Frameworks, Tools and Validation

One of the most significant weaknesses identified in the gap analysis (Section 5.5.4) is that **validation and recognition of skills remain largely dependent on national systems**, resulting in limited cross-border coherence and portability. National Qualification Frameworks, awarding bodies and accreditation authorities play a central role in ensuring institutional legitimacy, but their diversity contributes to fragmentation at European level.

These **National Validation and Recognition Systems** constitute essential enablers, as they provide the legal and institutional basis for formal recognition of competences. At the same time, their nationally governed nature reinforces the validation gaps identified in Section 5.5, particularly for sector-specific and non-formal learning outcomes that do not fit neatly into existing national qualification structures.

European digital credential infrastructures, notably the **European Learning Model (ELM)** and the **European Digital Credentials Infrastructure (EDC)**, address part of the validation and recognition gap by providing technical solutions for secure, portable and verifiable credentials. As highlighted in Section 5.5.4, however, these infrastructures do not validate competences themselves and rely on trusted issuers and recognised assessment processes, which remain external.

Bridging enablers therefore emerge as a response to the combined gaps identified in Sections 5.5.1 and 5.5.4: the lack of end-to-end skills pathways linking competence definition, assessment, validation and credentialing. These enablers operate at the interfaces between sector-level operational platforms, national validation systems and European digital infrastructures. While systematic bridging mechanisms are not yet fully established, the coexistence of these elements creates a **feasible foundation** for improved alignment and interoperability.

5.6 Implications for a Joint European Validation Framework

Building on the gaps identified in Section 5.4 and the analysis of existing enablers presented in Section 5.5, this section translates the evidence gathered into a set of

implications for the design of a joint European approach to skills validation and recognition in the battery sector. Rather than proposing a fully defined technical architecture or institutional model, the focus is on identifying design principles, functional boundaries and role allocations that follow logically from the observed characteristics of the current ecosystem.

The diversity observed between nationally standardised models (e.g., Finland) and decentralised, industry-led ecosystems (e.g., Germany) further highlights that any joint European validation approach must accommodate structural plurality. This reinforces the principle that coherence should be achieved through alignment mechanisms and interoperable interfaces rather than through centralisation.

The section, therefore, serves as a **conceptual bridge** between analysis and implementation. It outlines the conditions under which improved coherence, interoperability and sectoral relevance could be achieved, while respecting existing governance arrangements and the central role of national validation and recognition systems. Within this framework, pilot initiatives are considered as mechanisms for testing and operationalising these implications in practice, as further discussed in the final subsection.

5.6.1 Design Principles for a Joint European Validation Framework

The gap analysis presented in Section 5.4 revealed that the European battery skills ecosystem is characterised by a strong availability of frameworks, tools and infrastructures, but also by structural fragmentation across the skills lifecycle. Building on this analysis, a set of **design principles** can be derived to guide the development of a joint European approach to skills validation and recognition in the battery sector.

These principles do not prescribe specific solutions or institutional arrangements. Instead, they articulate **design implications** that follow logically from the identified gaps and from the nature of the existing enablers analysed in Section 5.5. As such, they provide a common orientation framework for initiatives seeking to improve coherence, interoperability and effectiveness in skills validation.

Linking gaps to design principles

Table 6 summarises the relationship between the main gaps identified in Section 5.5 and the corresponding design principles derived from the analysis.

Table 7 - Mapping of identified gaps to design principles

Identified gap (Section 5.5)	Design principle
Fragmentation across frameworks, tools and systems	Interoperability by design, not by ad-hoc integration
Uneven coverage of the battery value chain	Sector-level operationalisation rather than centralisation
Limited visibility of digital and green competences	Visibility and structuring of transversal competences
Weak linkage between skills definition and validation	End-to-end coherence without a single validation authority
Strong dependence on national validation systems	Complementarity with existing national systems

Principle 1 – Interoperability by design, not by ad-hoc integration

The analysis highlighted that fragmentation arises not from a lack of frameworks or tools, but from insufficient interoperability between them. This points to the need for interoperability to be embedded at design level, rather than addressed retrospectively through bilateral or project-specific integrations.

Interoperability by design implies that frameworks, platforms and tools use shared reference models, taxonomies and data structures from the outset, enabling consistent interpretation and reuse across systems. This reduces duplication and avoids reliance on fragile, ad-hoc mappings between otherwise disconnected solutions.

Principle 2 – Sector-level operationalisation rather than centralisation

Section 5.4 showed that sector-specific needs, particularly in a fast-evolving domain such as batteries, are not adequately addressed through highly centralised or generic approaches. Effective operationalisation therefore needs to occur at sector level, close to stakeholders.

Sector-level operationalisation refers to the translation of European reference frameworks into concrete job roles, skills descriptions and learning pathways that reflect the realities of a specific value chain. It does not imply the creation of new authorities, but rather the use of sector-focused platforms to contextualise and apply existing references.

Principle 3 – Visibility and structuring of transversal competences

The gap analysis identified limited and inconsistent integration of transversal digital and green competences within sector-specific competence models. This undermines comparability and weakens the contribution of skills initiatives to broader digital and sustainability transitions.

Visibility of transversal competences requires that digital and green skills are explicitly identified, structured and described alongside technical competences, using recognised European reference frameworks where appropriate. This supports transparency, comparability and reuse across sectors and qualification systems.

Principle 4 – End-to-end coherence without a single validation authority

One of the most critical gaps identified concerns the lack of coherence across the full skills lifecycle, from competence definition to validation and recognition. At the same

End-to-end coherence without a single validation authority means ensuring that competence definitions, assessment processes, validation outcomes and credentials are aligned and interoperable, while validation and recognition responsibilities remain distributed across national and sectoral actors. Coherence is achieved through orchestration and alignment, not through institutional centralisation.

time, validation authority remains firmly anchored in national systems, making centralisation neither feasible nor desirable.

Principle 5 – Complementarity with existing national systems

The strong dependence on national validation and recognition systems, identified as a weakness in Section 5.4, also reflects the institutional reality of skills governance in Europe. Any joint European approach must therefore build on, rather than attempt to replace, national structures.

Complementarity with national systems implies designing European-level approaches that respect national qualification frameworks, accreditation bodies and awarding authorities, while facilitating structured interaction and improved comparability across countries.

Concluding remark

Together, these design principles articulate a coherent response to the gaps identified in the European battery skills ecosystem. They define the **conditions under which improved validation and recognition can be achieved**, without introducing new authorities or parallel systems. In the following sections, these principles are used to clarify the functional scope and roles of different actors within a joint European validation framework, and to examine how they can be operationalised in practice.

5.6.2 Functional Scope of a Joint Validation Framework

The gap analysis demonstrated that many of the challenges faced by the European battery skills ecosystem are not the result of missing instruments, but of **unclear boundaries regarding roles, responsibilities, and functions**. In this context, defining the functional scope of a joint European validation framework is essential to ensure coherence while avoiding duplication, overreach, or institutional conflict.

Rather than introducing new validation structures, the functional scope of a joint framework should clarify **what functions can be supported at European and sector level**, and **what functions must remain within national systems**. This distinction is particularly important given the strong dependence of validation and recognition on national authorities, as identified in Section 5.4.

Functions that should be supported at the European and sector level

A joint European validation framework should primarily support functions that **enable alignment, transparency, and interoperability** across countries and stakeholders, without assuming validation authority.

In practical terms, this includes:

- supporting the definition and maintenance of sector-specific job roles and skills;
- enabling explicit referencing of transversal digital and green competences;

- facilitating links between competences, learning pathways and assessment processes;
- supporting the expression of validated outcomes through interoperable digital credentials.

At European and sector level, a joint framework should support the structuring and alignment of job roles, competences and learning outcomes; facilitate the articulation between sector-level competence definitions and European reference frameworks; and enable the use of interoperable digital credentials to improve portability and transparency of learning outcomes.

These functions respond directly to the gaps identified in Sections 5.4.1 and 5.4.3, where fragmentation and limited visibility of transversal competences were highlighted.

Functions that should remain within national systems

The analysis confirms that **formal validation and recognition of competences are inherently linked to national qualification systems**, legal frameworks and accreditation arrangements. Attempting to centralise these functions at European level would be neither feasible nor desirable.

Formal assessment, validation and certification decisions should remain the responsibility of national qualification authorities, awarding bodies and accreditation agencies. These functions ensure institutional legitimacy, regulatory compliance and alignment with national education and labour market systems.

This includes:

- formal assessment procedures leading to qualifications or certificates;
- awarding and recognition of qualifications within national frameworks;
- quality assurance and accreditation of assessment bodies.

By clearly delimiting these functions, a joint European framework avoids duplication and reinforces trust among national stakeholders.

Functions at the interface: enabling structured interaction

Between European/sector-level support functions and national validation systems lies a critical interface where **structured interaction** is required. The gap analysis identified this interface as one of the weakest points in the current ecosystem.

Interface functions enable competences defined and structured at sector level to be assessed and recognised within national systems, and subsequently expressed through interoperable credentials. These functions do not perform validation themselves, but support alignment and traceability across stages of the skills lifecycle.

Examples of such functions include:

- aligning sector-level competence descriptions with national qualification standards;

- supporting mutual understanding of learning outcomes and assessment criteria;
- facilitating the issuance of digital credentials by recognised national issuers.

Concluding remark

Defining a clear functional scope is a prerequisite for achieving end-to-end coherence without centralisation. By distinguishing between European and sector-level enabling functions, national validation responsibilities and interface functions, a joint European validation framework can support integration while respecting institutional boundaries. This clarification provides the basis for defining the roles and interactions of different actors within the ecosystem, as discussed in the following section.

5.6.3 Role of Sector-Level Platforms and European References

The analysis conducted in Sections 5.4 and 5.5 demonstrates that the effectiveness of a joint European approach to skills validation and recognition depends not only on the availability of frameworks and tools, but also on a **clear allocation of roles and well-defined interactions between actors**. Ambiguity regarding responsibilities was identified as a contributing factor to fragmentation and inefficiencies within the current ecosystem.

This section clarifies the respective roles of the main actors and layers involved, highlighting how their interactions can support coherence across the skills lifecycle while respecting existing governance structures.

European reference frameworks

European reference frameworks play a foundational role by establishing **shared concepts, taxonomies and competence structures** that enable alignment across sectors and countries. Their function is not to operationalise skills development or validation, but to provide common reference points that can be reused by sectoral platforms and national systems.

European reference frameworks define *what competences mean* in a shared European context. They support comparability, transparency and policy coherence, but do not perform assessment, validation or recognition functions.

This role directly addresses the fragmentation gap identified in Section 5.4.1 by reducing semantic inconsistencies between initiatives.

Sectoral competence references

Sectoral competence references contribute by contextualising European frameworks within the specific realities of an industrial value chain. In the battery sector, these references support a shared understanding of emerging job roles and skills across countries and stakeholders.

Sectoral competence references translate transversal and generic frameworks into sector-specific competence models aligned with industry needs. They operate at content level and support consistency, but do not define validation or certification mechanisms.

This role responds to the uneven value chain coverage identified in Section 5.4.2.

Sector-level operational platforms

Sector-level operational platforms play a central role in transforming reference content into **usable artefacts**, such as job role profiles, skills cards and learning pathways. By operating closer to industry and training stakeholders, they enable practical application of competence frameworks and support skills development initiatives.

Sector-level platforms operationalise competence frameworks by structuring job roles, skills and learning pathways in a form that can be used for training design, workforce planning and skills gap analysis, without assuming validation authority.

These platforms address the operational gap identified in Sections 5.4.1 and 5.4.2 by bridging the distance between abstract frameworks and practical use.

National validation and recognition systems

National validation and recognition systems remain responsible for **formal assessment, validation and certification** of competences. Their authority is rooted in national legal, regulatory and institutional frameworks, ensuring legitimacy and quality assurance.

National systems are the sole authorities for formal validation and recognition of competences. They ensure compliance with national qualification frameworks and quality standards, but operate according to diverse national rules and procedures.

This role reflects the structural dependency identified in Section 5.4.4 and explains why validation cannot be centralised at European level.

Digital credential infrastructures

European digital credential infrastructures provide the technical means to express validated learning outcomes in a **secure, interoperable and portable format**. While they do not validate competences themselves, they play a key role in supporting transparency and cross-border recognition.

Digital credential infrastructures enable the issuance, storage and verification of credentials in a standardised way, enhancing trust and portability of recognised learning outcomes without interfering with validation authority.

Their role directly addresses part of the recognition and portability gaps identified in Section 5.4.4.

Interactions between roles

Coherence across the skills ecosystem emerges not from the dominance of a single actor, but from **structured interactions between these roles**. European frameworks inform sectoral references; sector-level platforms operationalise competences; national systems validate and recognise learning outcomes; and digital infrastructures support credential portability.

The absence of clear interaction mechanisms between these roles was identified as a key weakness in the current ecosystem. Clarifying and supporting these interactions is therefore essential to achieving end-to-end coherence while preserving distributed governance.

Concluding remark

By clearly distinguishing roles and interactions, a joint European validation framework can reduce fragmentation without undermining existing authorities. This role-based perspective provides the foundation for examining how these interactions can be operationalised and tested in practice, as discussed in the following section.

5.6.4 Operationalising the Guidelines: The VOLTAGE Pilot Approach

The design principles, functional scope and role allocation outlined in the previous sections define a set of **guidelines for a joint European validation and recognition ecosystem** in the battery sector. Translating these guidelines into practice requires initiatives capable of operating across institutional, sectoral and national boundaries, while

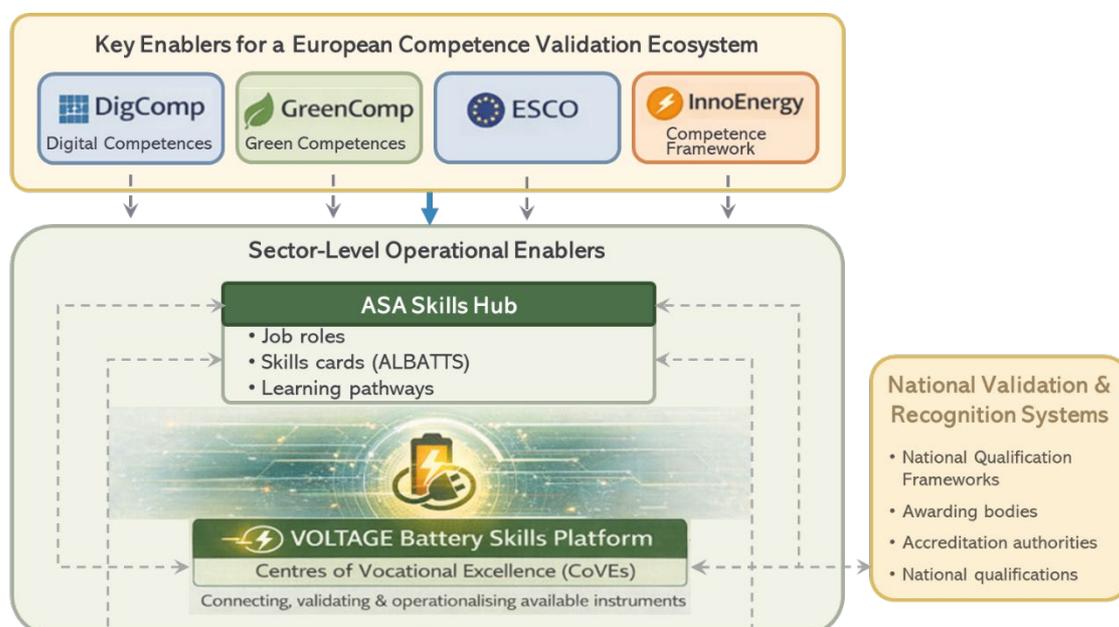


Figure 11 - Conceptual architecture for a joint European validation and recognition framework in the battery sector. The figure illustrates how existing European reference frameworks, sector-level operational platforms, national validation and recognition systems and digital credential infrastructures can be connected. The VOLTAGE project is positioned as a cross-layer pilot operating at the interfaces between these elements, without replacing existing authorities or systems.

respecting existing governance structures. In this context, pilot initiatives play a critical role by testing how alignment and interaction can be achieved in real-world conditions.

As illustrated in Figure 11 the joint validation and recognition framework is not conceived as a single system or authority, but as an ecosystem of interacting layers. The figure highlights the interfaces between sector-level operational platforms, national validation and recognition systems and European digital credential infrastructures, which constitute critical points of fragmentation in the current landscape and key areas for pilot-level operationalisation.

The **VOLTAGE project**, implemented through a network of **Centres of Vocational Excellence (CoVEs)** in multiple countries, provides such a pilot environment. Rather than introducing new frameworks or validation authorities, VOLTAGE is positioned as an **operational testbed** that explores how the identified enablers can be connected and mobilised in practice, in line with the design principles derived from the gap analysis.

As illustrated in Figure 11, the VOLTAGE pilot operates primarily at the interface between **sector-level operational platforms, national validation and recognition systems** and **European digital credential infrastructures**. Its role is not to substitute any of these layers, but to facilitate structured interaction between them by making use of existing instruments, processes and reference frameworks.

At sector level, VOLTAGE builds on existing job role definitions, skills cards and learning pathways developed within European initiatives, notably those consolidated within the ASA Skills Hub. These artefacts provide the operational basis for skills development and training design across the battery value chain. Through the CoVEs, these sector-level structures are applied, adapted and tested in diverse national contexts.

At national level, the VOLTAGE pilot engages with **national validation and recognition systems** through the participating CoVEs, which operate within national qualification frameworks and institutional arrangements. This allows the project to explore how sector-level competence definitions and learning outcomes can be assessed and recognised using existing national mechanisms, without attempting to harmonise or replace them.

In parallel, VOLTAGE examines the use of **European digital credential infrastructures**, notably the European Learning Model (ELM) and the European Digital Credentials Infrastructure (EDC), as technical enablers for expressing recognised learning outcomes in a portable and interoperable format. By focusing on the interface between validation outcomes and credential representation, the pilot contributes to understanding how digital credentials can support transparency and cross-border mobility in a sector-specific context.

Through this multi-level operationalisation, the VOLTAGE pilot generates **evidence on feasibility, limitations and conditions for scalability**. The value of the pilot lies not in delivering a final validation framework, but in informing future developments by testing how existing enablers interact, where frictions persist and which alignment mechanisms are most effective.

Concluding remark

By positioning VOLTAGE as a pilot initiative operating across key interfaces of the skills ecosystem, this section illustrates how the guidelines derived from the analysis can be explored in practice. The insights generated through such pilot activities provide a critical input for the refinement of joint European approaches to skills validation and recognition in the battery sector, while preserving flexibility and respect for national and sectoral diversity.

6. Conclusions

This report has examined the current European landscape of competence frameworks, self-assessment tools and validation models relevant to the battery sector, with a particular focus on their capacity to support coherent, transparent and cross-border recognition of skills. Through the mapping of existing initiatives and the subsequent gap analysis, it becomes evident that Europe already disposes of many of the **building blocks** required for a robust skills validation ecosystem. However, these elements remain **fragmented, unevenly connected and insufficiently operationalised at sector level**. The strategic challenge is therefore not the absence of competence frameworks, but the limited interoperability and cross-level alignment between them.

6.1 Key gaps in the current ecosystem

The analysis highlights several structural gaps that limit the effectiveness of existing approaches to skills validation and recognition in the battery sector. While competence frameworks are widely available at European, national and sectoral levels, their **translation into operational job roles, assessment practices and recognised outcomes remains inconsistent**. Coverage across the battery value chain is uneven, and emerging roles and skills are not always reflected in validation practices.

A critical weakness concerns the **lack of end-to-end coherence** across the skills lifecycle. Competence definition, assessment, validation, recognition and credentialing are often addressed through disconnected instruments, resulting in limited transparency and portability. In particular, validation and recognition remain **largely dependent on national systems**, which, while ensuring institutional legitimacy, constrain cross-border comparability and mobility.

At the same time, transversal digital and green competences — essential for the twin transition — are not systematically integrated into sector-specific validation approaches. European digital credential infrastructures offer significant potential to support portability and trust, but their uptake in sectoral validation contexts remains limited and uneven.

6.2 Conditions for a robust European validation system in the battery sector

The findings of this report indicate that the development of a robust European system for skills validation in the battery sector does not require the creation of entirely new frameworks or authorities. Instead, it depends on the **effective connection and orchestration of existing enablers**. European reference frameworks provide a shared conceptual basis; sector-level platforms enable operationalisation close to industry needs; national validation systems ensure legitimacy; and digital credential infrastructures support portability and verification.

A sustainable European approach must therefore be **complementary rather than centralising**, respecting national governance while enabling structured interaction across borders. End-to-end coherence can be achieved through alignment and interoperability, rather than through a single validation authority. Sector-level operationalisation emerges as a key condition for translating European references into practice, particularly in a fast-evolving and highly specialised sector such as batteries.

6.3 The contribution of the VOLTAGE project

Within this context, the VOLTAGE project represents an important opportunity to **operationalise and test** the guidelines identified in this report. Through its network of Centres of Vocational Excellence (CoVEs), VOLTAGE is uniquely positioned to act at the interfaces where fragmentation is most pronounced: between sector-level competence structures, national validation and recognition systems, and European digital credential infrastructures.

Rather than replacing existing frameworks or authorities, VOLTAGE contributes by **piloting structured connections** between them. By building on sector-level assets such as job role profiles and skills cards, and by engaging with national validation mechanisms in multiple countries, the project can generate evidence on how sector-specific competences may be assessed, validated and recognised in a way that supports cross-border transparency and mobility. The exploration of interoperable digital credentials further strengthens this contribution by addressing the technical dimension of recognition and portability.

6.4 Towards a European system for cross-border recognition in the battery sector

Taken together, the results of this study point towards the feasibility of a **European validation and recognition system for the battery sector** that supports cross-border recognition of profiles and competences without undermining national systems. Such a system would be characterised by shared reference frameworks, sector-level operational platforms, structured interaction with national authorities and the use of interoperable digital credentials.

The VOLTAGE project does not claim to deliver this system in its entirety. Its value lies in **testing, demonstrating and refining** how existing enablers can be combined in practice, providing concrete lessons for future policy development and large-scale implementation. In this sense, VOLTAGE contributes to strengthening Europe's capacity to respond to skills needs in the battery sector, supporting workforce development, mobility and competitiveness in a strategic industrial domain.

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