Good practice mapping

Report

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Executive Summary

Deliverable D3.2 presents the mapping of existing EU and international good practices related to the design, delivery, assessment, governance, and financial sustainability of micro-credentials (MCs). These practices will inform subsequent WP4 stakeholder consultations and WP5 methodological framework development.

The analysis integrates:

- Evidence from the methodological framework established in D3.1 and its mapping guidance (Annex 1) and case study criteria (Annex 2);
- National findings from Finland, Portugal, Spain, and pan-European/global practices.

Across countries, the mapping reveals:

- Expansion of short training in electric mobility, diagnostics, and digital skills;
- A fragmented landscape where most short courses *do not yet meet* the EU definition of MCs;
- Only a small number of fully aligned and interoperable MCs, mostly from universities, global consortia, or sectoral alliances;
- Industry-driven training ecosystems, particularly relevant for automotive maintenance and repair (M&R);
- Courses offered by providers within the formal VET system operate mostly disconnected from courses offered by nonformal providers- be it industry certifications or other forms of provision[1];
- Gaps in quality assurance, stackability, digital verifiability, and assessment standards

The good practices included here directly feed into D3.3 Case Studies (minimum 8 planned in the proposal) and will contribute to the design of the MCs value proposition (D4.2) and the methodological framework for pilots (WP5).

[1] Finland provides an interesting example of how courses to respond to safety originally developed by the private sector has been integrated in public VET provision. Similarly in Spain the certification providers TUV Rheinland has provided upskilling of VET teachers matching forefront practices in industry.

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Introduction

Purpose of the deliverable

Deliverable D3.2 – Good Practice Mapping consolidates the results of an extensive mapping exercise covering 112 training practices relevant to micro-credentials (MCs) in the automotive ecosystem. The mapping spans Spain (60 practices), Finland (20), Portugal (12) and 20 additional EU and international examples, capturing a diverse landscape of training and credentialing approaches across formal VET, CVET, private training provision, and industry-led certification.

The deliverable responds to the objectives of WP3, namely to:

- Identify and analyse approaches to governance, pedagogy, assessment, quality assurance, and financial sustainability in micro-credential ecosystems.
- Map existing training practices and credentialing systems across pilot countries and internationally, with a focus on the green and digital transitions in automotive maintenance and repair (M&R).
- Provide a structured knowledge base that informs stakeholder consultations (WP4), supports the design of the methodological framework for MC pilots (WP5), and underpins the selection of cases for Deliverable D3.3.

Through this comprehensive mapping, D3.2 builds an understanding of the current state of micro-credential-relevant practices in the automotive sector and related industries undergoing rapid technological transformation.

1.2 Methodological Approach

The mapping was conducted according to the methodology established in D3.1 – Methodology Pack , which sets out a systematic, comparable, and transparent approach to identifying, classifying, and analysing practices.

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A wide operational definition was applied (aligned with the 2022 Council Recommendation on Micro-credentials[2]) to ensure coverage of both formal and non-formal learning, industry certifications, short courses, modular VET units, and emerging forms of digital credentialing. The mapping examined practices across institutional types (public VET, private training providers, employer academies, higher education institutions (HEIs), OEM programmes), reflecting the heterogeneity of automotive upskilling ecosystems. This is consistent with the WP3 intent to bridge formal, non-formal, and industry provision.

Practices were prioritised based on the guidance in Annex 1 – Mapping Criteria :

- occupational relevance
- explicit learning outcomes
- assessment evidence
- provider credibility
- quality assurance
- transferability and scalability
- alignment with MC ecosystem dimensions

Every mapped item was categorised along the five dimensions of the MC ecosystem defined in WP3:

1. Governance
2. Pedagogy
3. Assessment
4. Quality Assurance
5. Financial Sustainability

The mapping drew on:

- national policy documents and regulatory frameworks
- programme and curriculum descriptions
- interviews with providers and stakeholders

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022H0627(02)

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- EU-funded projects (DRIVES, TRIREME, ALBATTS, MCEU, EBSI-VECTOR)
- provider websites and sector reports
- structured templates aligned with Annexes 1–3

This approach enabled both country-level depth and EU/global comparability, allowing the team to identify 112 practices of particular relevance out of which 10 were selected for further case study analysis in D3.3. Importantly, the notion of "good practice" in this mapping does not imply full compliance with the EU definition of micro-credentials. Rather, practices were selected because they demonstrate *one or more* strong elements across the five MC ecosystem dimensions (governance, pedagogy, assessment, quality assurance, financial sustainability), even when other dimensions remain underdeveloped. This analytical distinction is essential for WP5, which aims to design pilots that build upon existing strengths while addressing systemic gaps.

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1. MAPPING RESULTS

1.1 EU-wide and international developments

Across the EU and globally, MC adoption is being driven by:

- Green transition: electrification, battery systems, circular economy skills, sustainable mobility;
- Digital transition: diagnostics, cybersecurity, data, connected vehicles, AI-enabled maintenance;
- Labour shortages: particularly acute in automotive M&R (ACEA, EURES reports);
- Increased modularisation in VET and CVET systems (Finland, Portugal, Spain).

However, the mapping confirms that:

- Most short training courses lack formal assessment, digital interoperability, or stackability. This reflects a systemic trade-off whereby scalable short-course provision is rarely matched by sustainable assessment, quality assurance and credential interoperability, undermining stackability and labour-market signalling.
- National frameworks are evolving, but implementation is uneven. However, the opening up of national qualifications frameworks to partial qualifications, modularisation and competence based learning outcomes, and the deployment of validation and recognition practices offer an enabling environment for provision of more flexible learning that functionally has many of the characteristics of micro-credentials, which over time potentially can address that.
- Industry-led certifications are trusted but poorly linked with VET qualifications.

1.2 Mapping results: Spain

Spain has numerous short trainings in EV maintenance and safety, and several have been selected as promising MC good practices.

Practice 1 — FPCAT-UPC Micro-credentials in Electromobility (Catalonia)

- Type: University-led micro-credentials (3–6 ECTS)

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- Dimensions: Pedagogy, QA, Assessment, Stackability
- Strengths:
    - Digital issuance
    - ECTS-based workload
    - Stackable progression
- Relevance: Strong green transition relevance; EU-aligned structure
- Gap addressed: Lack of formalised EV micro-credentials in I-VET/C-VET

Practice 2 — National Catalogue of Training Specialties (Catálogo de Especialidades Formativas)

- Type: National CVET short modules
- Dimensions: Governance, QA, Pedagogy
- Strengths:
    - Nationally defined curricula
    - Regular updates with industry input
- Limitation: Not yet recognised as MCs, limited stackability

Practice 3 — DGUV-aligned High-Voltage Safety Certifications (delivered by Spanish providers)

- Type: Industry-recognised certification
- Dimensions: Assessment, QA, Recognition
- Strengths:
    - Standardised assessment
    - High employer trust

Practice 4 — OEM-led EV/ADAS upskilling modules (Ford, Volkswagen, Toyota Spain)

- Type: Brand-specific certification
- Dimensions: QA, Pedagogy, Employer relevance
- Strengths:
    - Highly relevant to connected vehicles
    - Competence-based assessment

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1.3 Mapping results: Finland

Finland does not yet systematically use the term “micro-credential” in national VET legislation; however, it has a highly modular, competence-based VET system and is currently undergoing significant reform aimed at increasing flexibility, learner choice, and responsiveness to labour market needs.

Practice 5 — SFS 6002 Electrical Safety Training

- Dimensions: Governance, Assessment, QA
- Strengths:
    - Mandatory national standard
    - Strong assessment model

Practice 6 — Live Working Certification for High-Voltage Batteries

- Dimensions: Assessment, QA, Employer trust
- Strengths:
    - Competence demonstration required

Practice 7 — Optional VET Unit: Maintenance Work on High-Voltage Vehicles

- Strengths:
    - Occupational relevance
    - Clear learning outcomes

Practice 8 — OEM Portal and Diagnostics Training (Volvo, Mercedes, Toyota)

- Dimensions: Pedagogy, Digital skills
- Relevance: Connected vehicle maintenance

1.3 Mapping results: Portugal

Portugal represents structurally mature environment for future micro-credential implementation among the pilot countries, despite the limited explicit use of the “micro-credential” label. The National Qualifications System (SNQ), anchored in the Catálogo Nacional de Qualificações (CNQ), already embeds several core MC principles, including learning-outcomes-based design, modularisation, formal assessment, credit

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accumulation, and national quality assurance. The main gap is therefore not structural capacity, but rather explicit articulation, digital credentialing, and interoperability with EU-level MC infrastructures.

Practice 9 — UFCD 10862 "Diagnosis & Repair in Hybrid & Electric Vehicles"

- Dimensions: Pedagogy, Assessment
- Strengths:
    - Formal assessment
    - Clear learning outcomes
- Potential as MC: Strong pathway into EV occupations

UFCD 10862 is particularly significant because it already functions as a de facto micro-credential within the CNQ architecture. It has defined learning outcomes, formal summative assessment, national recognition, and independent certification. Unlike most non-formal EV courses in other countries, UFCDs are explicitly designed to be accumulated, reused, and embedded within multiple qualification pathways (CETs, EFA courses, RVCC processes). This positions UFCD 10862 as a prime candidate for piloting EU-aligned micro-credentials with minimal regulatory disruption, especially if complemented by digital credential issuance and explicit EQF referencing.

Practice 10 — Specialist Technician in Automotive Mechatronics for EVs (NQF Level 5)

- Type: Post-secondary VET programme with modular components
- Strengths:
    - Stackability
    - Embedded modules suitable for MC extraction

While the CET itself is not a micro-credential, its internal structure—composed of certified Units of Competence (UC) and UFCDs—offers a clear pathway for "micro-credential extraction". Individual units already meet many EU MC criteria (assessment, workload definition, QA, national recognition) and could be re-issued as standalone or stackable micro-credentials without altering the legal status of the CET. This modular extraction logic is directly relevant for WP5 pilot design, particularly at EQF level 5.

Practice 11 — Private sector EV/HV safety certifications (CEAC, MasterD, etc.)

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- Dimensions: Pedagogy, Recognition
- Strengths:
    - Rapid response to industry needs
- Limitation: Quality assurance is uneven and often opaque, particularly regarding assessment validity and external review. However, several providers operate within DGERT accreditation requirements and align informally with CNQ standards, indicating partial—but undocumented—QA compliance. This suggests that targeted incentives and metadata standardisation could significantly raise transparency without eliminating private provision.

Practice 12 — ADAS Calibration and Digital Diagnostics (Bosch, OEMs)

- Dimensions: Assessment, Relevance
- Strengths:
    - Practical, tool-based competence demonstration

Portugal's key strength lies in its nationally coherent qualification architecture, which already operationalises many micro-credential principles through UFCDs and UCs. Unlike Spain or Finland, Portugal does not face a fragmentation problem, but rather a visibility and interoperability challenge. Strategic alignment with Europass Digital Credentials, explicit MC labelling, and employer-facing communication could transform existing provision into a mature MC ecosystem, particularly for EV and mechatronics pathways.

1.3 Mapping results: EU and international practices

This section presents international good practices that illustrate mature or emerging micro-credential ecosystems beyond the pilot countries. Three practices are highlighted as core international references in the mapping, because they demonstrate transferable and policy-relevant approaches to governance, stackability, assessment, and recognition, and have therefore been selected for in-depth analysis as case studies. Additional EU and international examples are included to contextualise specific ecosystem components (e.g. digital infrastructure, national frameworks).

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Practice 13 — Credential As You Go (CAYG) – Incremental Credentialing Ecosystem (USA)

- Type: System-level incremental credentialing ecosystem spanning higher education, workforce systems, and employers, Employer Engagement & Job Quality Signalling
- Dimensions: Governance, Pedagogy (pathway design towards sector occupations with growing demand for skilled work), Recognition/Portability, Financial Sustainability
- Strengths: Reconceptualises credentials as incremental milestones rather than end-points, supporting labour market mobility towards occupations and sectors with good employment prospects and lifelong learning; Strong emphasis on stackability and pathway logic. Pathways are co-designed with sector employers and workforce intermediaries to align learning units with occupational standards and progression routes to higher-quality jobs (wages, stability, advancement). Use of shared metadata standards (e.g. CTDL) to enhance transparency and employer understanding
- Limitations: Assessment and quality assurance practices vary across participating institutions; Model relies on voluntary alignment rather than binding accreditation rules; Commitment to recognising credentials in hiring and promotion varies by sector and region;
- Relevance for AutoCredify: CAYG offers a replicable logic for building EV, diagnostics, and safety competence pathways from smaller learning units.

Practice 14 — MicroCreds – National University-Led Micro-Credential Initiative (Ireland)

- Type: Nationally coordinated, university-led micro-credential framework
- Dimensions: Governance, Pedagogy, Assessment, Quality Assurance, Recognition, Ecosystem Linkages (sectoral and regional skills structures)
- Strengths: Clear national definition of micro-credentials aligned with EU Council Recommendation; All micro-credentials are credit-bearing (ECTS) and aligned with the National Framework of Qualifications; Strong embedded quality assurance through university accreditation and national QA bodies; Structured engagement with industry via national skills priorities, Regional Skills Fora, and sector-focused consultations, supporting alignment with priority sectors (e.g. digital, pharma,

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medtech, green technologies); Systematic employer engagement in design and validation of learning outcomes

- Limitations: Primarily anchored in higher education; limited direct coverage of VET and technician-level training; Employer recognition varies by sector and occupation. Interfaces with further education and apprenticeships remain weak and depend on local initiatives rather than national integration mechanisms;

Practice 15 — Automotive Skills Alliance (ASA) – Skills Hub Digital Badge (EU)

- Type: Sector-led EU-level digital badge and micro-credential platform
- Dimensions: Governance, Pedagogy, Assessment, Quality Assurance, Recognition/Portability, Sector & Regional Ecosystem Integration, Digital Infrastructure
- Strengths: Sector-driven governance under the Pact for Skills, involving OEMs, training providers, and social partners; Competence-based, modular design aligned with automotive job roles and EU skills intelligence; Digital badge issuance supports visibility, portability, and accumulation of learning outcomes; Linkages to regional pilot hubs, clusters, and Centres of Vocational Excellence enable contextualised delivery and employer uptake;
- Limitations: Recognition is community-based rather than embedded in national qualification frameworks; Assessment standards may vary between providers; Interoperability with national credential registers and VET information systems remains limited; Long-term financial sustainability depends on post-project funding and sector commitment
- Relevance for AutoCredify: ASA is directly relevant to automotive M&R and illustrates how sector-level recognition can complement formal VET systems, especially in contexts where national MC frameworks are still emerging.

Practice 16 — University of Pisa & Vitesco: Automotive Electronics & Powertrain Electrification

- Dimensions: Pedagogy, Assessment, QA
- Strengths:
    - University–industry co-design

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- Stackable

Practice 17 — 4EU+ Alliance "Micro-credentials for Innovation (MICI)"

- Strengths:
  - Multi-country interoperability
  - Cross-disciplinary design

Practice 18 — EBSI-VECTOR Micro-credential Infrastructure

- Dimensions: Governance, QA, Portability, Digital Infrastructure, Interoperability, Financial Sustainability
- Strengths: EU-level trust infrastructure enabling tamper-proof, verifiable credentials using distributed ledger technology; Full alignment with the European Learning Model (ELM) and European Digital Credentials for Learning standards; Supports rich, machine-readable metadata (learning outcomes, workload, EQF/NQF level, assessment type, QA references); Enables cross-border verification and interoperability with national wallets and credential platforms; Positions credentials as part of the broader European Digital Identity ecosystem
- Limitations: Uneven adoption across Member States and limited integration into national VET and higher-education information systems; Does not itself define credential quality, assessment standards, or occupational relevance, relying on external QA and sector frameworks; Onboarding and technical capacity requirements may be high for smaller providers and SMEs; Long-term financial sustainability and operational funding models beyond EU project cycles remain unclear, particularly regarding node operation, support services, and system upgrades
- Relevance for AutoCredify: Provides a future-proof trust and interoperability backbone for cross-border recognition of automotive micro-credentials; AutoCredify can leverage EBSI-VECTOR for verification and skills metadata exchange while retaining sector-specific governance over assessment standards, occupational signalling, and employer validation

Practice 19 — New Zealand NZQA Micro-credentials Framework

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- Type: Nationally regulated micro-credential accreditation and recognition system spanning higher education, ITPs, private providers, and industry training organisations
- Dimensions: Governance, Pedagogy (industry-driven skill standards and rapid programme approval), Assessment, Quality Assurance, Recognition/Portability, Employer Validation, Financial Sustainability
- Strengths: Formal national definition of micro-credentials (5–40 credits) embedded in the New Zealand Qualifications Framework (NZQF); All micro-credentials must demonstrate clear employer or industry need and include documented industry endorsement as part of accreditation; Centralised QA and fast-track approval processes enable rapid response to emerging skill needs (e.g. EV servicing, digital manufacturing, health technologies); Credit-bearing and stackable into larger qualifications; Strong signalling to employers due to NZQA branding and framework integration; Funding eligibility through national tertiary education funding mechanisms supports sustainability and provider participation

- Limitations: Strong regulatory framing may reduce experimentation with very short or informal learning units; International portability depends on bilateral or regional recognition rather than automatic cross-border mechanisms; Digital credential infrastructure and skills metadata practices are less standardised than in emerging EU frameworks; Sector-specific skills taxonomies are not always machine-readable for HR or recruitment systems
- Relevance for AutoCredify: Demonstrates how micro-credentials can be fully embedded in a national qualifications system while remaining modular and industry-responsive; offers a model for integrating employer validation, public funding, and stackability into technician-level upskilling pathways, which is directly relevant for automotive M&R and green-transition skills

Practice 20 — Canadian EV Technician MC Pathways

- Type: Multi-institutional micro-credential ecosystem for electric vehicle (EV) technician skills, combining short modular credentials, stackable training units, and employer-aligned pathways across colleges and training providers

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- Dimensions: Governance (institutional & industry engagement), Pedagogy (skills-based modular design), Assessment, Quality Assurance (institutional QA frameworks), Recognition/Portability, Stackability & Industry Alignment
- Strengths: Vertical and horizontal stackability across distinct EV micro-credentials allows learners to build from foundational to advanced skills and link into broader technician career paths; industry-oriented programs (e.g., EV Essentials training) feature multiple micro-badges that can be stacked into broader competencies and include job support elements — showing how micro-credentials can connect to labour-market entry and mobility. Programs often build on existing automotive certifications and leverage applied learning, hands-on labs, and competency-based assessments aligned to employer skill expectations. Modular credentials address specific EV skills needs (e.g., high-voltage safety, EV diagnostics, battery systems) relevant to employers in dealers, independent shops, and fleet environments; Many certificates and micro-credentials are directly aligned with industry demand and designed to update existing automotive technician competencies for electrification contexts (e.g., safe work practices, EV component diagnosis)
- Limitations: Lacks a single national governance or accreditation system for EV micro-credentials — approaches vary by province and institution; Recognition and portability depend on employer awareness, provincial credential frameworks, and institutional articulation agreements rather than a unified national standard; Quality assurance and assessment criteria may differ across providers, making cross-institutional comparisons and credit transfer complex; Financial sustainability and scaling of these pathways is influenced by project-based funding and institutional capacity rather than national policy mandates
- Relevance for AutoCredify: The Canadian EV micro-credential ecosystem illustrates how modular skills units and stackable credentials can be organized around rapidly evolving technical needs in automotive electrification; it offers practical models for industry alignment and incremental learning progression that AutoCredify can adapt, particularly in structuring occupationally relevant skill tiers and employer validation mechanisms

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1.4 Synthetic cross-practice comparison table

Practice	Governance	Pedagogy	Assessment	Quality Assurance	Financial Sustainability
FPCAT-UPC Micro-credentials in Electromobility (Spain)	Institutionally embedded within a public HE/VET hybrid framework; aligned with regional strategy and ECTS conventions	Modular, learner-centred design; clear progression pathways; blend of theory and applied learning	Formal summative assessment aligned with learning outcomes	Strong internal QA via university accreditation; transparent documentation	Mixed model: learner fees + public support; scalable within institutional offer
Spanish National Catalogue of Training Specialties	Strong national governance via PES and social partners; stable regulatory anchor	Standardised curricula; limited flexibility for individualisation	Assessment requirements defined but unevenly implemented	Provider accreditation and periodic review; QA stronger at design than delivery level	Publicly funded through PES; stable but risks fragmentation without pathways
DGUV-aligned HV Safety Certifications (Spain)	Sector-standard driven governance; strong employer recognition	Highly practice-based, safety-critical training	Rigorous, competence-based assessment	QA anchored in recognised technical standards	Employer-driven and fee-based; sustainable due to regulatory demand
OEM-led EV/ADAS Training (Spain)	Proprietary governance; brand-specific ecosystems	Tool- and workflow-centred pedagogy	Practical competence checks; varies by OEM	Internal OEM QA; limited external transparency	Fully employer-funded; sustainable but low transferability
SFS 6002 Electrical Safety Training (Finland)	Mandatory national standard; high legitimacy	Focused, safety-driven pedagogy	Formal knowledge tests; practical assessment varies	Standard-based QA; gaps in assessment standardisation	Stable due to regulatory requirement
Live Working / HV Battery Repair Certification (Finland)	Hybrid governance (national standard + providers)	Highly specialised, practice-intensive	Hands-on competence demonstration	QA uneven; limited external moderation	Employer-driven; sustainable in niche safety-critical roles
Optional VET Unit: HV Vehicle Maintenance (Finland)	Embedded in national VET governance	Modular, occupation-oriented	Formal VET assessment	National VET QA frameworks	Publicly funded; scalable within VET pathways
UFCD 10862 – Diagnosis & Repair in	Fully embedded in CNQ/SNQ governance;	Outcomes-based, modular design	Formal summative assessment	Strong national QA via ANQEP/DGERT	Publicly funded; high

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Practice	Governance	Pedagogy	Assessment	Quality Assurance	Financial Sustainability
HEV/EV (Portugal)	nationally recognised				scalability and reusability
Specialist Technician in Automotive Mechatronics (Portugal)	Strong national governance; qualification-level integration	Modular structure enabling MC extraction	Formal assessment at unit level	Robust QA through CNQ	Public funding + learner participation; sustainable
Private EV/HV Safety Certifications (Portugal)	Fragmented provider-level governance	Responsive, practice-oriented	Assessment often implicit or weak	QA uneven and opaque	Fee-based; market-driven sustainability
Credential As You Go – CAYG (USA)	System-level, multi-stakeholder governance; voluntary alignment	Strong pathway-oriented pedagogy	Assessment delegated to institutions	QA varies; transparency via metadata	Mixed public-private funding; scalable ecosystem
MicroCreds (Ireland)	Nationally coordinated governance; HE-led	Credit-bearing, modular pedagogy	Formal, outcomes-based assessment	Strong QA via university systems	Public investment + institutional integration
Automotive Skills Alliance – Skills Hub (EU)	Sector-led, Pact-for-Skills governance	Competence-based, modular learning; Building on systematic skills intelligence	Provider-defined assessments	Trust-based QA with light approval	Project-based; sustainability depends on sector uptake
University of Pisa & Vitesco (Italy)	University-industry co-governance	Applied, stackable modules	Formal academic assessment	University QA + industry validation	Institutional funding; replicable partnerships
4EU+ MICI Alliance	Consortium-based EU governance	Cross-disciplinary, modular	Formal HE assessment	Multi-institutional QA	Project-based; scalable with continued EU support
EBSI-VECTOR Infrastructure	EU-level governance comprised of participating MS and partners (Not all MS are engaged)	Enables pedagogical interoperability indirectly via data standards) see my comment	Not applicable	It provides technical and administrative QA infrastructure (verifiability, integrity, traceability).Strong system-level QA logic	Public investment; enabling infrastructure, but does not cover delivery costs
NZQA Micro-credentials (NZ)	National accreditation framework with mandatory employer/sector validation	Flexible, modular pedagogy	Mandatory assessment	Strong external QA	Stable public-regulated funding

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Practice	Governance	Pedagogy	Assessment	Quality Assurance	Financial Sustainability
Canadian EV Technician MC Pathways	Provincial / sectoral governance	Pathway-based, Modular, occupationally targeted learning addressing specific skills gaps	Mandatory outcome based competence-based assessment	Strong alignment with industry standards Strong external QA via NZQA approval and monitoring	Employer co-investment; high sustainability; Publicly regulated funding linked to workforce priorities

2. Implications for WP4 and WP5 and overall conclusions

The mapping of practices across Spain, Portugal, Finland and a wider set of EU and international examples confirms a rapidly evolving but uneven micro-credential landscape. Governance is a key differentiator shaping coherence, trust, and labour-market signalling. Where national micro-credential frameworks exist, expectations around workload, learning outcomes, assessment and quality assurance are clearer, supporting transparency and trust.

In Spain the micro-credential concept is not yet widely used as formal terminology; however, the VET system is already built on a modular, competence-based architecture that incorporates many core micro-credential features. Initial and continuing VET programmes are structured around units of competence defined in the National Catalogue of Professional Qualifications (CNCP), enabling partial certification, accumulation, and recognition of prior learning within coherent qualification pathways. Recent reforms further strengthen flexibility and graded certification. The main challenge therefore lies less in modular design and more in the systematic labelling, digital issuance, and interoperability of smaller learning units outside the formal qualification framework.

Portugal differs from Spain in that its CNQ/UFCD modular architecture already embeds many micro-credential principles (learning outcomes, national recognition, formal assessment and QA), but micro-credential labelling, digital issuance and EU interoperability are not yet systematically operationalised.

Finland shows another variant: VET is competence-based and modular, and safety-critical training is strongly

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anchored in standards (e.g. SFS 6002), yet MC-specific governance and digital credentialing are still emerging, and assessment and delivery practices can vary between providers.

Pedagogical approaches vary widely. Stronger examples (e.g. university-led micro-credentials, OEM modules and structured EV pathways) combine modularity with hands-on learning aligned to real diagnostic and safety workflows. However, transversal competences (communication, digital problem solving, customer-facing safety communication, systems thinking) remain unevenly integrated, particularly in non-formal segments where courses stay narrowly technical—limiting transferability across roles and technologies.

Assessment is one of the clearest dividing lines between robust MC-like practices and generic short courses. Industry and standards-based certifications (DGUV-aligned HV safety, SFS 6002 and live-work battery repair training, and many OEM validations) tend to use supervised testing and competence demonstrations suited to safety-critical work. By contrast, many non-formal EV and diagnostics courses rely on attendance-based or weakly specified assessment, undermining recognisability, portability and trust—precisely the issues the European approach to micro-credentials seeks to address.

Quality assurance follows a similar pattern. Where credentials are embedded in national or institutional QA systems, mandatory information elements (learning outcomes, workload, level, assessment type, QA basis) are more consistently documented. In fragmented private training markets, QA is often opaque, making it difficult for employers and learners to distinguish robust offers from superficial ones. This points to the value of shared metadata and transparent credential descriptors as low-regret improvements even before full regulatory reforms.

Financial sustainability influences whether training remains a set of disconnected short courses or evolves into pathways. In Spain and Portugal, public subsidies and training funds can expand access but may also incentivise course proliferation without integration unless funding is linked to stackability and validated assessment. International models such as CAYG's pathway logic and ASA's sectoral badge ecosystem illustrate how modular credentials can be made visible and valuable when connected to occupational progression and shared recognition mechanisms.

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Across cases, the wider comparison suggests that **no single layer is sufficient**: national frameworks strengthen trust; sector alliances strengthen occupational relevance and employer uptake; and digital public infrastructure enables verifiable, cross-border portability. The absence—or weak coupling—of any of these layers tends to reproduce fragmentation, even where modular and competence-based training already exists.

For WP4 stakeholder consultations, the mapping highlights **five priorities**:

(1) establishing a shared understanding of what constitutes a micro-credential in the automotive M&R context;

(2) clarifying how industry certifications can articulate with public VET and qualification frameworks;

(3) agreeing minimum expectations for safety-critical assessment (performance-based tasks, supervision, rubrics, moderation);

(4) identifying governance and metadata requirements for employer trust and portability; and

(5) discussing funding models that reward pathway design and stackability rather than isolated provision.

For WP5, pilots should focus on domains where the mapping shows both strong demand and high potential for harmonisation—EV safety and handling, HV diagnostics, ADAS calibration and connected-vehicle maintenance. Pilot MCs should leverage existing modular infrastructure (Portugal's UFCD/UC units, Finland's modular VET units and standards-based credentials, and Spain's Catalogue of Training Specialties) while strengthening weak points: practical competence-based assessment, explicit QA statements, stackability rules, and digital credential descriptors aligned with EU mandatory information elements. Where feasible, alignment with European digital credential infrastructures can further support verification and portability across providers and countries.

Taken together, the mapping confirms that the automotive **M&R sector is rich in training activity** but still uneven in aligning short-form provision with EU micro-credential principles. The practices highlighted in this deliverable demonstrate the potential for transformation through rigorous assessment, on-going developments in the opening up of national qualifications frameworks, modular pathway design,

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deployment of validation and recognition of prior learning, stakeholder co-creation, digital verifiability and transparent quality assurance—forming a practical foundation for WP4 value proposition work and WP5 pilot methodology.

3. Cross-cutting Good Elements and Replicable Mechanisms for MC Design

This chapter distils across the mapped practices those elements that appear most promising for replication in the AutoCredify pilots and in subsequent methodological work under WP4 and WP5. Rather than revisiting each practice individually, the analysis focuses on how different systems and providers operationalise the five MC ecosystem dimensions – governance, pedagogy, assessment, quality assurance, and financial sustainability – and what this implies for transferability to the automotive maintenance and repair (M&R) context across different national and sectoral settings. The narrative draws both on the mapping evidence and on the analytical lenses defined in the D3.1 methodology pack and Annex 1–2 guidance on selection criteria and MC dimensions. In this chapter, 'replicable mechanisms' refers to practical design and implementation features (e.g., pathway logic, assessment rubrics, metadata standards, governance agreements, and funding arrangements) that can be transferred and adapted across providers and countries.

3.1 Governance – From Fragmented Initiatives to Coherent Architectures

A first clear pattern concerns governance. Across the mapping, the most robust and "MC-like" practices emerge where system-level rules and responsibilities are clearly defined. New Zealand's NZQA micro-credentials and Australia's national micro-credential framework represent the most explicit examples: they provide a coherent language, set of design rules, and accreditation processes that apply across providers. In these contexts, the term micro-credential is not an isolated innovation but part of a wider qualification architecture, with clear expectations regarding learning outcomes, workload, level, assessment and QA. This stands in contrast to Spain and Finland, where the micro-credential concept is still weakly institutionalised at system level; Portugal differs in that its CNQ/UFCD architecture already embeds many MC principles

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(learning outcomes, modularity, assessment, national QA), even if explicit MC labelling and EU interoperability are not yet systematically operationalised. At the same time, the mapping shows that governance does not need to start from scratch. In all three pilot countries, there are pre-existing regulatory instruments that already contain many of the necessary building blocks. The Spanish National Catalogue of Training Specialties and Portugal's CNQ/UFCD structures, for example, already define nationally approved curricula, learning outcomes, assessment rules and provider accreditation mechanisms. These systems are currently used for CVET and modular training, not explicitly labelled as micro-credentials; however, they can be seen as "proto-MC infrastructures" that could be upgraded rather than replaced. The Finnish case similarly illustrates how modular VET structures and mandatory safety standards (such as SFS 6002) create a governance baseline that could support future MC development even in the absence of a dedicated MC law. In Finland, standards-based governance (notably SFS 6002 and its annexes) provides strong legitimacy for safety-critical competence, but delivery and assessment practices can still vary across providers, highlighting the need for common credential descriptors and verification.

At the same time, Finland's strong role for social partners and sectoral bodies in qualification design creates both an opportunity and a constraint: micro-credentials can be aligned with occupational standards, but only if they are clearly embedded in recognised pathways and not perceived as bypassing collective governance arrangements.

More broadly, the mapping points to significant differences in how VET governance systems mediate the acceptance of micro-credentials. In tripartite systems with strong social-partner involvement—such as in Germany, Austria and parts of the Nordic model—there is documented concern that micro-credentials may contribute to the "unbundling" of qualifications, weaken occupational identities, and undermine collectively negotiated skill standards. In such contexts, trade unions and employer associations often view micro-credentials with caution unless they are clearly linked to formal qualifications, regulated occupational profiles and collectively governed standards-setting processes. This political economy dimension of skills governance is critical: without social-partner buy-in, MC initiatives risk remaining peripheral or project-based.

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By contrast, in more state-steered or hybrid systems—such as Portugal's SNQ/CNQ architecture or Spain's PES-driven CVET system—governance levers are more concentrated in public agencies, enabling faster rollout of modular provision but also increasing the risk of fragmentation if strong pathway logic and employer validation are not built in. This implies that governance challenges are not only technical but institutional: the same MC design may be feasible in one country and contested in another, depending on how responsibilities for qualification design, funding and recognition are distributed between government, employers and social partners.

A complementary governance pattern emerges from multi-stakeholder and consortium-based models. The Pisa–Vitesco collaboration, the 4EU+ MICI alliance and EU-wide infrastructures like EBSI-VECTOR demonstrate how shared governance can be organised across institutional and national boundaries. In these arrangements, universities, industry, regional authorities and technology providers co-define learning outcomes, update content, and agree on compatibility with EU instruments such as the European Learning Model or EBSI. For AutoCredify, these examples suggest that governance reform does not have to be purely top-down. A plausible path is a hybrid model in which national frameworks (catalogues, CNQ, VET regulations) are combined with sectoral alliances around EV and diagnostics, and where OEMs, VET providers and public agencies jointly oversee MC families related to safety-critical domains.

New Zealand "micro-credentials on the NZQF" model and U.S.-style federated systems such as Credential As You Go further illustrate that coherent MC ecosystems do not require a single central issuer, but they do require strong coordination mechanisms, shared data standards, and labour-market governance links. In these systems, labour-market data, sector strategies and regional economic development priorities play an explicit role in shaping which credentials are approved, funded and scaled—linking credential governance to job-quality and sector-growth agendas rather than to training supply alone.

These governance patterns matter because they determine how modular learning designs are recognised, quality-assured and financed—issues examined in the next sections.

Replicable governance mechanisms emerging from the mapping include:

- formalising issuer roles and responsibilities (who designs, who awards, who validates);

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• establishing a shared 'MC family' structure for EV safety/diagnostics (common titles, levels, stack rules);

• creating lightweight multi-stakeholder steering (VET, including social partners where VET is tri-partite governed, + employers + standards bodies) for update cycles;

• adopting common metadata conventions to ensure portability and transparency.

While system-level governance (national frameworks, qualification catalogues, sector bodies) sets the regulatory scaffolding for micro-credentials, institutional governance determines whether MCs are *coherent*, *sustainable*, and *strategic* within individual providers. Cross-country and international experience shows that strong institutional governance is what distinguishes fragmented pilot initiatives from scaled, high-impact micro-credential systems.

What a Fit-for-Purpose Governance Model Should Cover in AutoCredify

For AutoCredify, governance must ensure that micro-credentials function as trusted, scalable building blocks within vocational pathways and sector skill systems, not as stand-alone courses. This requires governance that integrates competence standards, assessment, provider capacity, business models and employer uptake.

1. Decisions on What Should Be Offered as Micro-Credentials

Governance must define selection criteria for MC development, based on:

- safety-critical or rapidly changing technologies (e.g. EV, diagnostics, ADAS),
- clearly identifiable workplace tasks, and
- strong employer demand or regulatory drivers.

This prevents MCs from duplicating full qualifications and focuses them on skills that benefit from short, targeted micro-credentials and micro-credentials pathways.

2. Integration with Overall VET and CVET Provision

MCs must be governed as part of the institution's and sector's full training portfolio, not as parallel offers. Governance should ensure:

- alignment with qualification units and apprenticeships,
- recognition of MCs as entry requirements or credit towards further learning, and

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- coherence between public VET, private training and OEM systems.

This supports progression and avoids undermining occupational standards.

3. Credential Families and Pathway Logic

Rather than approving isolated courses, governance should define MC families with:

- clear prerequisites,
- stacking rules, and
- links to occupational profiles.

This supports career mobility and makes MCs meaningful for recruitment and compliance.

4. Teacher and Assessor Competence as a Governance Requirement

Credibility depends on who teaches and assesses. Governance should require:

- up-to-date occupational competence,
- pedagogical capability for adult and workplace learning, and
- training in performance-based assessment and evidence documentation.

External moderation and assessor calibration should be used for safety-critical skills to ensure comparability across providers.

5. Comparable and Auditable Assessment Practices

MCs should be awarded only where:

- assessment reflects real workshop tasks,
- criteria are standardised and externally validated where possible, and
- evidence is documented for QA and verification.

Attendance-based certificates should not qualify as MCs in technical domains.

6. Digital Credential and Metadata Standards

Governance must define minimum requirements for:

- learning outcomes, level and workload,
- assessment type and QA reference, and
- skills tagging for labour-market signalling.

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This enables verification, portability and integration with HR and public systems.

7. Business Model, Funding and Provider Incentives

MC governance must address how provision is financed and prioritised:

- how MC delivery fits within public funding and fee-based training models,
- incentives for providers to invest in equipment, staff training and digital systems, and
- mechanisms to reduce cost barriers for SMEs and individual workers.

Without viable business models, MCs remain project-based and unsustainable.

8. Outreach, Employer Uptake and Market Signalling

Governance should also cover how MCs are communicated and used:

- employer involvement in validating relevance,
- clear signalling of what MCs certify and how they relate to jobs and compliance, and
- coordination with sector bodies and employment services to support uptake.

Without visibility and employer recognition, even high-quality MCs will have limited impact.

9. Continuous Updating and Sector Feedback Loops

Finally, governance must require:

1. Subject to continuous review and renewal

   Effective MC governance requires regular academic and industry review cycles, including:

   - Curriculum updates based on skill intelligence, technological change, and pedagogical innovation
   - Quality assurance audits specific to modular credentials
   - Evidence of labour-market outcomes linked to MC achievement

2. Embedded in institutional QA and data systems

   Micro-credentials must be integrated into a provider's quality assurance, student record and reporting systems, enabling consistent documentation, transparency and eventually interoperable digital verification.

Why Governance and Institutional Embedding Matter for AutoCredify

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AutoCredify's success depends not only on designing technically sound micro-credentials, but on demonstrating how they can be embedded in normal VET and sector training systems, with credible assessment, qualified teachers and assessors, sustainable business models, and strong employer uptake. Without governance over what is offered as a micro-credential, how it aligns with qualifications and OEM training, how providers are incentivised, and how credentials are recognised in recruitment and compliance, micro-credentials risk remaining fragmented pilot initiatives rather than becoming scalable instruments for the green and digital transition in automotive maintenance and repair.

At provider level, **institutional governance is a critical enabling condition** for this embedding:

- Credibility and trust: Without clear internal policies on learning outcomes, performance-based assessment and quality assurance, employers and learners may not trust micro-credentials as evidence of competence. Empirical studies show that employer acceptance is closely linked to perceptions of institutional quality and governance, not only to credential format (Holmes, 2021).
- Coherence across provision: When micro-credentials are developed as isolated projects in different departments, outcomes, titles and levels become inconsistent, undermining stackability and portability. Institutional governance is needed to ensure that MCs form part of a coherent training portfolio linked to occupational pathways.
- Strategic alignment with labour-market demand: While system-level frameworks may permit micro-credentials, institutions decide which skills are prioritised, which learner groups are targeted, and how offerings link to sector pathways and employer needs. Without such portfolio-level governance, provision risks responding to funding opportunities rather than to sustained labour-market demand.
- Monitoring outcomes and equity: Strong institutional governance enables tracking of participation, completion, employment outcomes and access for SMEs and disadvantaged learners. This is essential both for continuous improvement and for justifying public and sector investment in modular upskilling (OECD, 2022).

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Policy experimentation should therefore explicitly explore what feasible governance models look like for taking micro-credentials from pilot initiatives to full institutional implementation. In AutoCredify terms, this means that sector-validated competence standards, robust assessment practices, digital verification, and clear pathway logic must be underpinned by provider-level governance arrangements

3.2 Pedagogy – Modular, Practice-based and Pathway-oriented Design

On the pedagogical dimension, the mapping confirms the importance of modularity and pathway thinking. Some of the strongest pedagogical designs, such as the FPCAT-UPC electromobility micro-credentials, the Portuguese CNQ units and the Canadian EV technician pathways, adopt an explicitly modular structure in which each unit has clearly defined learning outcomes and workload, but is also situated within a broader occupational progression. Learners can complete small chunks of learning that address immediate skill gaps while retaining the possibility to accumulate these modules into larger credentials. This is particularly relevant for automotive M&R, where technicians often need to add specific competences (e.g. high-voltage safety, ADAS calibration) without interrupting work for long periods.

The mapping also highlights that practice-based, tool-centred pedagogy is a key feature of credible training in EV and diagnostics. OEM-led modules in Spain and Finland, ADAS calibration courses in Portugal, and several international digital diagnostics credentials all emphasise hands-on work with real vehicles, diagnostic tools, and software platforms. Learning in these programmes is organised around authentic workflows—making an EV safe to work on, diagnosing a high-voltage fault, calibrating ADAS after a repair—rather than abstract theory. This aligns strongly with the methodological emphasis in D3.1 on occupational relevance and competence-based approaches.

The mapping also reveals an important distinction between learning-outcomes-based pedagogical design (typical of education and VET systems) and performance-standards-based competence models (more common in industry certifications and professional regulation). While learning outcomes describe what a learner should know or be able to do after training, performance standards specify how well tasks must be performed under defined conditions, often linked to safety, liability and regulatory compliance. In safety-

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critical domains such as high-voltage systems and ADAS calibration, employers and professional bodies tend to place greater trust in performance standards than in curriculum descriptors alone. This creates different "zones of trust": education systems prioritise learning outcomes and qualifications, labour markets prioritise demonstrated task competence, and professional or regulatory bodies prioritise compliance with formal technical standards.

For micro-credentials to function credibly across these zones, pedagogy must therefore be designed not only around learning outcomes but also around observable task performance aligned with recognised standards. This strengthens the case for co-design of MC learning activities with industry and standards bodies, ensuring that what is taught and practised maps directly onto what is regulated, audited and insured in real workplaces. In this sense, authentic performance-based assessment becomes the critical bridge—and connective "glue"—between educational validity, labour-market relevance and regulatory trust. Without such assessment practices, micro-credentials risk being recognised in education systems but discounted by employers and compliance authorities, particularly in safety-critical occupations.

However, the mapping also reveals an important in pedagogical design as transversal skills integration is uneven. While some international examples (e.g. MICI, Pisa–Vitesco) deliberately embed transversal competences such as communication, digital problem solving or systems thinking, many of the mapped EV and diagnostics courses in the pilot countries remain narrowly technical. This limits learners' ability to transfer their skills across roles or adapt to evolving technologies. For AutoCredify, this suggests that the pilots should not only replicate modular, practice-based designs, but also systematically weave transversal and customer-facing competences into MC learning outcomes and activities, especially in areas like fault communication, safety communication to clients, and collaborative diagnostics. A further replicable pedagogical element is structured recognition of prior learning (RPL)—especially relevant for experienced technicians transitioning into EV and ADAS roles—so that MCs can shorten learning time while maintaining assessment integrity.

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Replicable pedagogical mechanisms include: (i) task-based learning organised around workshop workflows; (ii) modular units designed for 'stop-and-go' participation by employed technicians; (iii) explicit pathway maps showing how units stack into specialisation roles; and (iv) integration of transversal outcomes directly into technical tasks rather than as separate add-ons.

3.3 Assessment – Demonstrating Safety-critical Competence

Assessment emerges as one of the clearest differentiators between robust micro-credentials and generic short courses. Where practices are well aligned with MC principles, assessment is explicitly designed to demonstrate competence in high-stakes contexts. DGUV-based high-voltage safety certifications, Finland's SFS 6002 training and live working certifications, and ADAS calibration modules all require trainees to perform critical tasks under supervision—isolating high-voltage systems, working on live battery components, calibrating sensors—and to meet transparent performance criteria. These models go beyond simple attendance or theoretical tests, and in doing so, anchor the credibility of the credentials among employers. A key replicable mechanism in safety-critical domains is the use of standardised performance rubrics (aligned to learning outcomes) combined with documented evidence (e.g., observation checklists, practical artefacts, supervisor sign-off), and—where feasible—external moderation or peer review to improve reliability across providers.

By contrast, many short courses mapped in Spain and Portugal rely on descriptive, attendance-based, or purely theoretical assessment, when assessment is specified at all. In such cases, even when content is relevant, the absence of rigorous assessment undermines recognisability, portability and trust, the overall labour market signalling value of Micro-credentials - precisely the issues identified in the EU Recommendation and in D3.1. This assessment gap is therefore not a marginal technical issue but a structural weakness that any MC development effort must address first.

Another set of replicable elements concerns transparency and digitalisation of assessment. University-linked examples such as FPCAT-UPC and Pisa–Vitesco formalise assessment through clear rubrics tied to learning outcomes, often mapped to EQF or institutional level descriptors. EU-wide infrastructures such as EBSI-VECTOR and Diplomasafe demonstrate how tamper proof digital credentialing can capture assessment

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information in a structured, verifiable way, including type of assessment, workload, level and quality assurance references. This can be further strengthened through skills-based tagging—linked to specific skills, proficiency levels, and occupational contexts—and by attaching evidence artefacts (e.g. videos of performance, project outputs, or supervisor validations), thereby significantly enhancing labour-market signalling and employer trust in micro-credential claims. For the planned pilots, these patterns suggest a dual priority: designing competence-based, practical assessments as the default for EV and diagnostics MCs, and ensuring that the results of those assessments are represented in digital credentials using the mandatory EU information elements.

Where assessment practices align with micro-credential (MC) principles, assessment is explicitly designed to demonstrate competence in high-stakes contexts, covering technical skills and transversal skills (e.g. problem solving, communication, professional judgement) in an integrated manner. (OECD 2023[3])

Authentic, performance-based assessment is essential in safety-critical competence domains, but it is also more resource-intensive than classroom-based or online testing. It requires access to equipped workshops, vehicles or battery systems, trained assessors, supervised task execution, and structured documentation. These requirements increase delivery costs and logistical complexity, particularly for small private providers and micro-enterprises that lack dedicated training infrastructure. If authentic assessment is not financially and organisationally sustainable, providers face strong incentives to revert to low-cost, attendance-based or theory-only testing models, even when these are poorly aligned with occupational requirements. This creates a systemic risk that micro-credentials become “short courses with better labels” rather than trusted competence signals. Addressing assessment sustainability is therefore not only a pedagogical issue but a

[3] OECD (2023) *Innovating Assessments to Measure and Support Complex Skills*. Paris: OECD Publishing. https://www.oecd.org/en/publications/innovating-assessments-to-measure-and-support-complex-skills_e5f3e341-en.html

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business-model and system-design challenge that must be considered explicitly in pilot implementation and scaling strategies (OECD 2025[4]).

In response to both skills demands and the disruptive capabilities of generative AI, assessment design is increasingly moving toward evaluating what learners can do in realistic contexts, rather than what they can reproduce in controlled written formats. UNESCO's guidance on generative AI emphasises that education systems should strengthen assessment approaches that better capture higher-order competences and authentic performance, while updating assessment policies and integrity measures for an AI-rich environment (UNESCO 2023)[5]. In the automotive M&R context, this reinforces the priority of practical assessment tasks aligned to real workshop workflows (e.g. safe shutdown procedures, fault diagnosis sequences, ADAS calibration protocols, customer-facing safety communication), with evidence captured in a structured way that supports portability and employer trust (OECD 2023).

The mapping and international practice suggest several assessment models that can improve feasibility and sustainability (Budiman R.D.A, Surjono H.D., Firdaus 2025)[6]:

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1. Shared assessment centres and pooled infrastructure: consortia-based centres operated by VET providers, employer associations, or regional hubs (including OEM-aligned facilities) to share vehicles, tools, diagnostic platforms and assessor capacity across multiple issuers.
2. Workplace-embedded assessment with certified supervisors: assessment integrated into normal production workflows under approved workplace supervisors, with standardised rubrics and

[4] OECD (2025) *Empowering the Workforce in the Context of a Skills-First Approach*. Paris: OECD Publishing.

[5] Mishra Shitanshu, Deep Anurag Advancing education: evolving assessments with AI. UNESCO 2023

[6] Budiman R.D.A, Surjono H.D., Firdaus W.M. Kurniati T., Feladi V, Oktarika D., Hakki M., Sabir A. Wiyoko T. Kadir A., Hamid M.A. Fadi R. (2025) *Effectiveness of AI-Driven Assessments in Enhancing Learning Evaluation through Predictive Technology in* Vocational Secondary School. In International Journal of Information and Education Technology, Vol. 15, No. 7, 2025

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periodic external moderation (reducing time away from work and minimising duplication of facilities).

3. Mobile assessment units and regional workshop clusters: mobile labs serving local networks of SMEs, enabling practical assessment without requiring each provider to maintain expensive equipment.
4. Hybrid models combining simulation + targeted in-person demonstration: low-risk elements assessed through validated simulations and scenario-based tasks, with high-stakes elements assessed in person (reducing the number of fully supervised in-workshop sessions required).

These models support cost-sharing and economies of scale, making robust assessment more viable beyond project funding. They also strengthen the case for employer co-investment because assessment is closely linked to operational productivity, compliance and safety liability management (OECD 2025).

AI is beginning to be used to *augment* assessment systems, rather than replacing expert judgement—especially in safety-critical vocational contexts. International guidance stresses the need for human oversight, clarity about acceptable AI use, and attention to fairness, transparency, privacy and accountability. (UNESCO, 2025; OECD, 2025) In the context of micro-credentials in automotive M&R, AI can support assessment in four practical ways:

- AI can help standardise and quality-check assessor judgements by flagging rubric inconsistencies, missing evidence, or unclear feedback—reducing variance between providers and improving reliability at scale. This is particularly relevant in multi-provider ecosystems where comparability is a core trust requirement. (Governance and risk management guidance remains essential.)
- AI-enabled tools can potentially assist in structuring assessment evidence (e.g. auto-generating structured observation summaries from assessor notes; organising photos/videos of task performance; linking evidence to learning outcomes). This lowers administrative burden and improves auditability—key for QA and employer verification.
- Where simulation validity is established (e.g. diagnostic reasoning sequences, fault isolation decision paths, customer communication scenarios), AI can help generate varied scenarios, track

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learner decisions, and score performance against criteria—reserving in-person assessment for high-risk physical tasks. This can materially reduce cost while preserving an authentic competence signal. EU JRC work on emerging GenAI practices in education reinforces that early adopters are experimenting with new workflows and assessment adaptations in response to GenAI[7].

- A forward-looking trend is to permit AI tools in some assessments—*with disclosure*—and assess the learner's ability to use them responsibly (e.g. documenting prompts, validating outputs against standards, identifying errors, applying professional judgement). Jisc's guided approach to GenAI in assessment captures this shift toward assessing the *process* and the learner's critical evaluation of AI outputs, rather than banning tools outright.

At the same time, AI introduces risks that are particularly relevant for micro-credentials: model bias, opacity of automated scoring, privacy/data protection constraints, and "false assurance" if AI-generated feedback is mistaken for verified competence. OECD work highlights that AI's benefits must be weighed against costs, commercial dependencies, and inclusion risks—reinforcing the need for governance, transparency and human oversight in assessment design. Accordingly, in safety-critical automotive domains, AI could potentially be positioned as an efficiency and consistency layer around human-led competence assessment—not as an autonomous assessor.

EU-wide infrastructures and digital credential approaches can capture assessment information in a structured, verifiable way, including type of assessment, workload, level and quality assurance references—aligning with the Council Recommendation's emphasis on clear credential descriptors, including assessment type.

[7] Villar Onrubia, D., Cachia, R., Rietz, C., Feltrero, R., Niemi, H., Hallissy, M. & Reuter, R. (2025). *Generative Artificial Intelligence in secondary education: uses and perceptions from the perspective of early adopters across five EU Member States*. Publications Office of the European Union, Luxembourg. JRC144345. Available at: https://data.europa.eu/doi/10.2760/8636621 (Accessed: date)

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Policy experimentations should explicitly test not only learning outcomes and credential formats, but also operationally viable assessment models that can be sustained after project funding ends. This includes documenting cost drivers (assessor time, equipment, facilities, moderation), identifying scalable models (shared centres, workplace assessment, hybrid simulation), and potentially specifying minimum governance requirements for AI-supported components (human oversight, transparency, data protection, and audit trails). UNESCO and Jisc guidance can be used as practical reference points for responsible integration of generative AI into assessment design and integrity practices.

3.4 Quality Assurance – Making Reliability Visible

Quality assurance is closely intertwined with governance and assessment but merits separate attention because of its role in making reliability visible to external users. In the mapping, where MCs or MC-like practices are embedded in national QA systems—as in New Zealand, Australia, and to some extent within CNQ and the Spanish Catalogue—key quality parameters are standardised. These include requirements to clearly state learning outcomes, workload, assessment type, and level; to conduct regular reviews; and, in some cases, to align with national or sectoral standards. Learners and employers thus receive a signal that a given credential has passed through a recognised scrutiny process, even if they do not know the issuing provider personally. However, this type of information does not give any indications on the relative labour market value of a specific credential for a given target group.

The mapping also shows that employer involvement in QA processes can be a powerful complement to formal systems. OEM academies and DGUV- or SFS-based certifications often rely on technical standard bodies, manufacturer guidelines, or sector organisations to validate content and assessment methods. In these cases, QA is tightly coupled to industry standards and technology cycles: when the standards evolve, the associated training and certification must be updated. This dynamic form of QA is particularly relevant in a fast-changing field such as EV and connected vehicle technology.

Another replicable QA mechanism is a defined update cycle linked to skills intelligence and technology change (e.g., periodic review, trigger-based updates after standards/OEM changes), ensuring that MC content remains current in fast-evolving EV and connected vehicle domains

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Conversely, QA is often weakest in the fragmented private provision ecosystems observed in Spain and Portugal, where information on assessment methods, completion rates or learner outcomes is rarely public. This opacity makes it difficult for learners, public authorities and employers to distinguish robust offers from superficial ones. From a replication perspective, one key lesson is that improving QA is not only about adding control mechanisms, but also about adopting common metadata standards and transparency practices. EU frameworks such as the European Learning Model and EBSI, as referenced in D3.1 and Annex 1, provide concrete tools for encoding QA-relevant information (e.g. QA type, recognition, stackability) into the digital representation of the credential itself. For the AutoCredify pilots, ensuring that each MC includes explicit QA descriptors and, where possible, external or employer-based validation, will be essential to build trust.

Digital credential infrastructures, skills intelligence and transparency

The European credentialing infrastructure comprises a set of EU frameworks and digital services that support the issuance, description, storage and verification of learning credentials across borders, including the Europass Digital Credentials Infrastructure (EDCI)[8], the European Learning Model (ELM)[9] for structured credential data, ESCO for skills and occupations[10], EBSI or similar emerging trust based services, and the EU Digital Identity (EUDI) Wallet[11] –the user-facing portability and control layer for secure, user-controlled sharing of credentials. Together, these components provide strong foundations for authenticity, portability and verification.

From a quality-assurance perspective, these infrastructures are not only technical tools for preventing fraud, but also mechanisms for making the content and credibility of credentials visible and comparable across

[8] https://europass.europa.eu/en/european-digital-credentials

[9] The ELM provides the first unitary and comprehensive data model across the European Education Area. https://europa.eu/europass/elm-browser/index.html

[10] https://esco.ec.europa.eu/select-language?destination=/node/1

[11] https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://ec.europa.eu/digital-building-blocks/sites/spaces/EUDIGITALIDENTITYWALLET/pages/694487738/EU%2BDigital%2BIdentity%2BWallet%2BHome

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providers and countries. Structured digital credentials can, in principle, expose key quality attributes such as learning outcomes, assessment type, level, recognition status and stackability, enabling employers, learners and public authorities to evaluate whether different offers meet comparable standards.

However, their contribution to quality monitoring and skills intelligence depends largely on how learning outcomes and competences are encoded by issuers. In practice, outcomes are often described in narrative form or inconsistently mapped to skills taxonomies, which limits the use of digital credentials as machine-readable signals for skills mapping in fast-changing technical fields, for dynamic labour-market analytics, and for curriculum renewal. When skills are not described in structured and comparable ways, systems cannot easily detect gaps, overlaps or outdated content, and quality assurance remains largely input-focused rather than outcome- and relevance-oriented.

Without sufficiently granular, standardised and regularly updated skills descriptors, digital credential infrastructures cannot support feedback loops between labour-market change, provider updating practices and public funding decisions. Strengthening semantic standards and update governance is therefore not only a technical interoperability issue, but a core requirement for quality assurance in dynamic occupational fields such as EV systems and connected vehicles.

From a replication perspective, improving QA is therefore not only about adding control mechanisms, but also about adopting common metadata standards, structured skills descriptors and transparency practices that support comparability and system-level learning. EU frameworks such as the European Learning Model and EBSI, as referenced in D3.1 and Annex 1, provide technical tools for encoding QA-relevant information (e.g. assessment type, recognition status, stackability, issuer and level), but these tools only deliver value for skills intelligence if issuers apply consistent, sufficiently granular and regularly updated skills descriptors.

Trainer, trainer-of-trainers and assessor competence as a QA cornerstone

Digital verification and metadata, however, cannot compensate for weaknesses in delivery capacity. In safety-critical and fast-changing domains such as EV systems and ADAS calibration, trainer and assessor competence becomes a central component of quality assurance, not a background assumption. If teachers

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and assessors lack up-to-date technical skills or cannot apply performance standards consistently, even well-designed micro-credentials risk losing labour-market credibility.

Spain (Navarre) as an illustrative case of certification-based teacher upgrading

Evidence from Spain illustrates both the strengths and limitations of current approaches to upgrading VET teacher competence in emerging automotive technologies. Initial responses to the introduction of EV and hybrid vehicle content relied mainly on short, online awareness courses for teachers, which provided general technological overviews but limited practical preparation for safe workshop instruction. Teacher feedback indicated that such courses were overly theoretical and insufficient for supporting hands-on teaching in safety-critical domains.

A more structurally significant response emerged in the 2023–2024 regional teacher training programme in Navarre, where VET teachers responsible for vehicle-maintenance modules were enrolled in a three-level High-Voltage Electric Vehicle Safety certification pathway delivered by TÜV Rheinland. The programme combined online introductory training with in-person practical instruction using real vehicles, tools and workshop environments, and progression between levels was conditional on successful completion of both theoretical and practical assessments.

Crucially, Levels 2 and 3 led to DGUV 209-093–aligned TÜV certifications, which are internationally recognised, industry-based safety credentials used in professional EV maintenance contexts. This meant that participating VET teachers were not only receiving pedagogical training, but they were certified against the same performance and safety standards applied to technicians in industry. Assessment included written tests and supervised practical tasks carried out on real vehicles, directly linking teaching competence to regulated occupational practices.

From a quality-assurance perspective, this model is significant because it demonstrates how standards-based professional certification schemes can be used to upgrade the technical competence of teachers and assessors, not only that of learners. It also shows how public VET systems can remain responsive to rapid technological change by leveraging external certification bodies that update training and assessment

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protocols in line with evolving safety standards and equipment requirements, rather than relying solely on slower curriculum-revision cycles.

The Navarre case therefore illustrates a replicable pathway for strengthening micro-credential quality:

- pedagogical responsibility and public certification remain anchored in the VET system;
- technical validation and safety compliance are anchored in recognised industry certification schemes; and
- trainer competence is treated as an explicit quality condition rather than an implicit assumption.

This represents a promising "dual anchoring" model of quality assurance, combining public-sector educational governance with industry-validated performance standards.

Toward minimum competence standards and mandatory updating cycles

The Spanish case highlights a broader structural issue: while curricula may specify learning outcomes and teacher profiles, they do not automatically guarantee technical currency in fast-evolving fields. In safety-critical occupational domains, this suggests the need for explicit minimum competence standards for trainers and assessors, combined with mandatory updating cycles linked to technology and regulatory change.

While some VET systems (e.g. Australia) require trainers and assessors to demonstrate current industry skills as part of quality regulation, and many safety-certification schemes require periodic renewal, the mapping does not indicate that EU VET systems systematically impose domain-specific re-certification cycles for teachers in emerging technical fields such as EV systems. Instead, updating requirements are most often enforced through industry safety schemes, OEM training ecosystems or employer compliance regimes, rather than through teacher qualification law alone. For AutoCredify, the mapping underscores that trainer and assessor capability should be treated as a first-order quality-assurance dimension, not as an implicit background condition. **In WP5 pilots, quality frameworks should therefore include**:

- technical certification or standards-aligned training required for trainers and assessors defined by standards setting bodies and industry.

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- structured industry-linked train-the-trainer pathways
- evidence of recent vocational practice or manufacturer/standards updates
- periodic assessor calibration against common performance rubrics.
- mandatory refresh requirements (e.g. every two years, or triggered by regulatory or technology updates); and
- public documentation of trainer and assessor requirements within credential descriptors.

Implications for micro-credential quality, signalling and scaling

Beyond educational quality, micro-credentials also function as labour-market signals that reduce information asymmetries between training providers, workers and employers. In fragmented automotive M&R labour markets—dominated by SMEs and micro-enterprises—transparent credential descriptors, trusted assessment standards and visible quality-assurance mechanisms are critical for efficient recruitment, task allocation and compliance with safety regulations. Without such signalling functions, short courses may improve individual skills but fail to translate into improved employability and sector-wide productivity gains.

In addition to input- and process-oriented quality measures, several international workforce systems increasingly incorporate labour-market outcome metrics as part of credential quality assessment. Such metrics typically track post-training employment, earnings progression and job retention across different learner groups, including holders of prior VET qualifications, low-qualified adults and long-term unemployed participants. Disaggregated outcome data of this kind are particularly important in publicly funded training markets, where quality should be assessed not only by curriculum compliance but by real employment impact for vulnerable groups.

In the United States, the *Credential Value Index (CVI)* developed by the Burning Glass Institute represents a concrete example of an outcome-based data tool linking labour-market outcomes to specific credentials. By showing which credentials are associated with wage gains, career progression and re-employment, the CVI

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introduces data-driven transparency that goes beyond traditional administrative QA criteria and is used by workforce agencies to guide funding and training pathway decisions.

Making credential content, assessment methods and skill coverage visible in structured digital form is not only valuable for individual learners and employers, but also for public employment services and VET authorities responsible for funding, steering and reforming training systems. For employment services, comparable credential data linked to labour-market outcomes enables better targeting of training offers for unemployed and at-risk groups, more evidence-based purchasing of training services, and more accurate guidance to jobseekers about which pathways lead to sustainable employment. For public VET systems, structured outcome data supports curriculum updating, capacity planning and investment decisions in areas where skills demand is evolving rapidly, such as EV maintenance and digital diagnostics.

Introducing outcome-oriented transparency also creates the basis for a more connected credentialing ecosystems and greater coherence in pathways for end users.

When Micro-credentials are assessed not only by compliance with formal curricula but also by demonstrable employment and progression outcomes for different learner groups, funding and recognition decisions can shift toward evidence of real labour-market impact rather than institutional status alone. This can encourage quality-based competition, reward providers that invest in robust assessment and industry alignment, and reduce incentives for volume-driven short-course provision with limited employment value.

In this sense, outcome-linked digital credential infrastructures can support the opening of qualification and recognition systems in a more coherent and accountable way, allowing credentials from both public and private providers to be referenced against common performance, skills and employment indicators. Rather than weakening public qualification systems, this form of transparency can strengthen system governance by enabling “selective permeability”—where new micro-credentials and industry certifications are recognised not because of who issues them, but because of demonstrable competence standards and labour-market relevance.

For AutoCredify, incorporating basic outcome tracking into pilot design—particularly for unemployed and low-qualified learners—could significantly strengthen the evidence base for future scaling and policy uptake.

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Even limited post-training follow-up indicators, when linked to credential metadata, would enhance transparency, support funding alignment and reinforce micro-credentials as instruments of labour-market integration rather than solely as short training certificates.

Minimum QA package for AutoCredify pilots

- a clearly designated quality-assurance owner with responsibility for both credential integrity and continuous improvement;
- a defined periodic review and update schedule linked to technological, regulatory and standards-setting changes, and informed by skills-demand signals where available;
- documented assessment formats and performance rubrics with transparent pass/fail criteria;
- explicit trainer and assessor qualification and technical-currency requirements;
- publication of structured credential metadata for employer verification and system-level comparability across providers; and
- where public funding or vulnerable learner groups are involved, basic post-training labour-market outcome indicators disaggregated by learner group and provider type.

Without such mechanisms, micro-credentials risk achieving formal compliance with learning-outcome frameworks while failing to secure labour-market and regulatory trust—particularly in domains where safety, liability and insurance regimes depend on demonstrable technical competence rather than on curriculum descriptors alone.

This raises a broader structural question of whether VET systems are sufficiently agile to support rapid and continuous updating of curricula and assessment regimes in response to technological and regulatory change. Cedefop's analysis of micro-credentials in evolving qualifications systems suggests that micro-credentials often emerge precisely where established qualification structures struggle to adapt quickly enough to changing labour-market requirements, and that modularisation is frequently seen as an enabling

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condition for more responsive training provision (Cedefop, 2023a[12]). However, Cedefop's end-user perspective also shows that employer trust in micro-credentials depends strongly on visible assessment practices, issuer credibility and transparent quality conditions—features that are not automatically ensured in fragmented short-course markets (Cedefop, 2023b[13]). This creates a tension between responsiveness and reliability that is particularly salient in safety-critical automotive occupations.

One pragmatic response to this tension is closer integration between micro-credentials offered by VET providers and certifications delivered by industry and standards-based organisations. Industry certifications are often updated more rapidly because they are directly linked to equipment specifications, safety protocols and liability regimes, while VET providers contribute strengths in learning-outcomes design, pedagogical structure and public QA mechanisms. Cedefop's work indicates that micro-credentials can function as building blocks within broader qualification architectures and support combinations of credentials across institutional and sectoral boundaries, provided that recognition arrangements and quality conditions are in place (Cedefop, 2023a[14]). In practical terms, this suggests designing MCs where learning outcomes, assessment rubrics and evidence requirements are co-defined with industry actors, while issuance and documentation are anchored in recognised VET QA frameworks. Such "dual anchoring" can increase both responsiveness to technology change and credibility in the labour market.

The feasibility of such integration is, however, strongly influenced by the relative openness of national qualifications frameworks (NQFs) and recognition systems. Cedefop's cross-country analysis shows that

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[12] Cedefop (2023a) *Micro-credentials for labour market education and training: Micro-credentials and evolving qualifications systems*. Luxembourg: Publications Office of the European Union.

[13] Cedefop (2023b) *Micro-credentials for labour market education and training: the added value for end users*. Luxembourg: Publications Office of the European Union.

[14] *Cedefop (2023a) Micro-credentials for labour market education and training:* Luxembourg: Publications Office of the European Union.

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some NQFs are opening to qualifications and credentials awarded outside formal education and training, while others remain more closed, limiting the extent to which sectoral or professional certifications can be referenced, accumulated or used in recognition-of-prior-learning pathways (Cedefop 2023 c[15] ,Cedefop 2025[16]

the formal system, which are now included in the framework. 'These qualifications are usually highly relevant to the labour market and can improve learners' employability'.

The European credentialing infrastructure comprises a set of EU frameworks and digital services that support the issuance, description, storage and verification of learning credentials across borders, including the Europass Digital Credentials Infrastructure (EDCI), the European Learning Model (ELM) for structured credential data, ESCO for skills and occupations, emerging EBSI-based trust services, and the EU Digital Identity (EUDI) Wallet for secure user-controlled sharing of credentials. Together, these components provide strong foundations for authenticity, portability and verification. However, their contribution to real-time skills intelligence depends largely on how learning outcomes and competences are encoded by issuers. In practice, outcomes are often described in narrative form or inconsistently mapped to skills taxonomies, which limits the use of digital credentials as machine-readable signals for skills mapping in fast-changing technical fields. date for dynamic labour-market analytics or curriculum renewal.

This creates a risk that digital credentials become "verified but not actionable": formally authentic, but weak as instruments for workforce planning, occupational forecasting and continuous quality improvement unless semantic standards and update governance are strengthened alongside technical infrastructures. This limitation is particularly relevant in fragmented private provision ecosystems such as those observed in Spain and Portugal, where information on assessment methods, completion rates, skill coverage or learner

[15] Cedefop (2023c*) Micro-credentials and evolving qualifications systems.* Luxembourg: Publications Office of the European Union.

[16] Cedefop (2025) Making qualifications and skills more visible . POLICY BRIEF The potential of national qualifications frameworks (NQFs) in the Union of Skills

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outcomes is rarely public. Such opacity makes it difficult for learners, public authorities and employers to distinguish robust offers from superficial ones, and it constrains the development of shared skills intelligence across providers. From a replication perspective, improving QA is therefore not only about adding control mechanisms, but also about adopting common metadata standards, structured skills descriptors and transparency practices that support comparability and system-level learning. EU frameworks such as the European Learning Model and EBSI, as referenced in D3.1 and Annex 1, provide technical tools for encoding QA-relevant information (e.g. assessment type, recognition status, stackability, issuer and level), but these tools only deliver value for skills intelligence if issuers apply consistent, sufficiently granular and regularly updated skills descriptors.

Evidence from Spain illustrates both the strengths and the limitations of current approaches to upgrading VET teacher competence in emerging automotive technologies. Initial responses to the introduction of EV and hybrid vehicle content relied mainly on short, online awareness courses for teachers, which provided general technological overviews but limited practical preparation for safe workshop instruction. Teacher feedback indicated that such courses were overly theoretical and insufficient for supporting hands-on teaching in safety-critical domains.

A more structurally significant response emerged in the 2023–2024 regional teacher training programme in Navarre, where VET teachers responsible for vehicle maintenance modules were enrolled in a three-level High-Voltage Electric Vehicle Safety certification pathway delivered by TÜV Rheinland. The programme combined online introductory training with in-person practical instruction using real vehicles, tools and workshop environments, and progression between levels was conditional on successful completion of both theoretical and practical assessments.

Levels 2 and 3 led to DGUV 209-093–aligned TÜV certifications are internationally recognised, industry-based safety credentials used in professional EV maintenance contexts. This implies that participating VET teachers were not only receiving pedagogical training, but were being certified against the same performance and safety standards applied to technicians in industry. Assessment included written tests

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and supervised practical tasks carried out on real vehicles, directly linking teaching competence to regulated occupational practices.

From a quality-assurance perspective, this model is significant because it demonstrates how standards-based professional certification schemes can be used to upgrade the technical competence of teachers and assessors, not only that of learners. It also shows how public VET systems can remain responsive to rapid technological change by leveraging external certification bodies that update training and assessment protocols in line with evolving safety standards and equipment requirements, rather than relying solely on slower curriculum revision cycles.

The Navarre case therefore illustrates a replicable pathway for strengthening micro-credential quality:

- pedagogical responsibility and public certification remain anchored in the VET system;
- technical validation and safety compliance are anchored in recognised industry certification schemes; and
- trainer competence is treated as an explicit quality condition rather than an implicit assumption.

For future micro-credential development in EV/HV and ADAS domains, this suggests that systematic use of standards-aligned, certifiable train-the-trainer pathways—potentially with mandatory refresh cycles—could form a core component of quality assurance, ensuring that both delivery and assessment capacity remain aligned with current regulatory and technological requirements.

This model illustrates a promising “dual anchoring” approach to quality assurance:

- pedagogical responsibility and certification authority remain within the public VET system;
- technical competence and safety validation are anchored in recognised industry and standards-based certification schemes.

Toward minimum competence standards and mandatory updating cycles

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The Spanish case highlights a broader structural issue: while curricula may specify learning outcomes and teacher profiles, they do not automatically guarantee technical currency in fast-evolving fields. In safety-critical occupational domains, this suggests the need for explicit minimum competence standards for trainers and assessors, combined with mandatory updating cycles linked to technology and regulatory change.

While some VET systems (e.g. Australia) require trainers and assessors to demonstrate current industry skills as part of quality regulation, and many safety-certification schemes require periodic renewal, the mapping does not indicate that EU VET systems systematically impose domain-specific re-certification cycles for teachers in emerging technical fields such as EV systems. Instead, updating requirements are most often enforced through industry safety schemes, OEM training ecosystems, or employer compliance regimes, rather than through teacher qualification law alone.

Implications for micro-credential quality and scaling

50 Without such mechanisms, micro-credentials risk achieving formal compliance with learning-outcome frameworks while failing to secure labour-market and regulatory trust—particularly in domains where safety, liability and insurance regimes depend on demonstrable technical competence rather than on curriculum descriptors alone.

For micro-credentials in EV/HV and ADAS domains, a replicable quality-assurance model could therefore specify:

- baseline technical certification or standards-aligned training required for trainers and assessors, co-defined with relevant industry or standards bodies and social partners in tri-partite governed systems;
- evidence of recent vocational practice or documented manufacturer/standards updates;
- periodic assessor calibration against common performance rubrics to ensure comparability across providers;

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- mandatory refresh requirements (e.g. every two years, or triggered by regulatory or major technology updates); and
- public documentation of trainer and assessor requirements within structured credential descriptors, enabling employer verification and system-level transparency.

Beyond educational quality, micro-credentials can also function as labour-market signals that reduce information asymmetries between training providers, workers and employers. In fragmented automotive M&R labour markets—dominated by SMEs and micro-enterprises—transparent credential descriptors, trusted assessment standards and visible quality assurance are critical for efficient recruitment, task allocation and compliance with safety regulations. Without such signalling functions, short courses may improve individual skills but fail to translate into improved employability and sector-wide productivity gains. In addition to input and process-oriented quality measures, several international workforce systems increasingly incorporate labour-market outcome metrics as part of credential quality assessment. Such metrics typically track post-training employment, earnings progression and job retention across different learner groups, including holders of prior VET qualifications, low-qualified adults and long-term unemployed participants. Disaggregated outcome data of this kind are particularly important in publicly funded training markets, where quality should be assessed not only by curriculum compliance but by real employment impact for vulnerable groups. Introducing outcome-based transparency mechanisms can therefore strengthen both accountability and social equity in micro-credential ecosystems. In the U.S., the *Credential Value Index* (CVI), developed by the Burning Glass Institute, [17]represents a concrete example of an outcome-based data tool that links real-world labour-market outcomes with specific credentials. The CVI draws on millions of anonymised career histories to measure how more than 23,000 non-degree credentials—

[17] IAWP Online (2025) *How the Credential Value Index Helps Us See What Really Works*. Available at: https://iawponline.org/news/making-sense-of-credentials-how-the-credential-value-index-helps-us-see-what-really-works/ (accessed January 9th 2026)

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including certifications, professional courses and other short-form qualifications—impact employment, wage growth, career transitions and skills acquisition. By showing jobseekers, employers and workforce agencies which credentials are associated with significant wage gains, career advancement or successful re-employment, the CVI introduces data-driven transparency to credential quality and economic value that goes beyond traditional administrative QA criteria[18]. Tools like CVI are being used by workforce development authorities and state agencies to guide investment decisions, funding eligibility and training pathway advice, especially for disadvantaged groups who have historically lacked reliable signals about credential return on investment. For AutoCredify, incorporating basic outcome tracking into pilot design—particularly for unemployed and low-qualified learners—could significantly strengthen the evidence base for future scaling and policy uptake. Even limited post-training follow-up indicators, when linked to credential metadata, would enhance transparency, support funding alignment, and reinforce the positioning of micro-credentials as instruments of labour-market integration rather than solely as short training certificates.

3.5 Financial Sustainability – Aligning Incentives and Pathways

Financial sustainability shapes which micro-credential (MC) practices persist beyond project phases and which remain isolated or short-lived initiatives. However, the mapping also reveals a significant evidence gap: for most cases reviewed, systematic information on participant numbers, unit costs, development costs, assessment costs and ongoing updating requirements is not publicly available. This limits the ability to evaluate long-term financial viability and scalability, particularly in technically complex and safety-critical domains such as EV systems, high-voltage safety and ADAS calibration, where delivery and assessment are inherently resource-intensive.

Flexible and personalised learning pathways are only cost-effective if validation and recognition are themselves funded and operationally supported. In many systems, public funding is primarily attached to course participation rather than to competence assessment or validation processes, creating incentives to

[18] Burning Glass Institute (2025) *Credential Value Index (CVI) Methodology*. Available at: https://www.credentialvalueindex.org/methodology (Accessed: 9 January 2026).

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enrol learners in full training programmes even when targeted assessment would suffice. This leads to inefficient use of training resources, longer time away from productive work, and reduced motivation among experienced workers. Sustainable micro-credential ecosystems therefore require funding formulas that explicitly cover validation, assessment and recognition activities—including assessor time, moderation and documentation—alongside course delivery. Public employment services, sectoral training funds and employer co-investment schemes can play a central role in financing such validation pathways, ensuring that public resources support competence upgrading rather than unnecessary retraining.

Ultimately, financial sustainability shapes which MC-like practices survive beyond project phases and which remain one-off initiatives. The mapping reveals several funding logics that can be built upon. In Spain and Portugal, large volumes of EV-related training are funded via public employment services or training funds such as FUNDAE, allowing workers and jobseekers to access courses at little or no cost. While this broad funding base supports high participation, it may also contribute to a proliferation of disconnected short courses if not accompanied by pathway thinking and quality criteria. A replicable sustainability mechanism is 'pathway conditionality': linking public subsidies or training-fund support to (i) validated assessment, (ii) publication of MC descriptors, and (iii) clear stackability rules—so funding reinforces coherent pathways, and the systematic use of labour-market outcome data for relevant target groups, rather than supporting disconnected short courses. In practice, such conditionality can be operationalised through several existing governance instruments: by referencing eligible micro-credentials within more open national qualifications frameworks (NQFs); by embedding QA and outcome requirements into public employment service (PES) procurement and voucher schemes; and by aligning eligibility for sectoral training funds to compliance with recognised assessment standards and credential metadata conventions. In these models, NQFs provide the recognition logic, PES systems provide purchasing power, and sectoral funds provide co-investment incentives—together creating aligned financial signals that reward high-quality, labour-market-relevant micro-credentials rather than volume-based provision.

In this way, funding becomes an explicit lever for quality assurance: only credentials that meet defined requirements for assessment, transparency, updating and recognition are eligible for public or collective

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financing, aligning financial sustainability with compliance to QA standards rather than with training volume alone.

Examples from Canada and the United States illustrate co-investment models in which employers bear part of the cost of modular, stackable credentials precisely because they see them as integral to workforce development strategies. However, these models may risk excluding small workshops and self-employed technicians unless collective financing mechanisms or sectoral training funds are in place. This raises an important equity dimension: who ultimately bears the cost of participation when collective training funds, public subsidies or personal learning accounts are unavailable or insufficient? In such contexts, micro-credentials risk becoming predominantly learner-financed, which may disadvantage low-qualified workers, older technicians and those in precarious employment—precisely the groups most affected by technological transition. Without mechanisms to spread costs across employers, public systems and individuals, micro-credentials may inadvertently reinforce rather than reduce skills inequalities.

In practice, the full cost structure of micro-credential provision extends far beyond teaching hours. It includes instructional design and continuous curriculum updating; acquisition and maintenance of vehicles, diagnostic tools and simulation equipment; assessor training and calibration; digital credential infrastructure; outreach and learner guidance services; skills-intelligence functions that monitor labour-market demand and credential outcomes; and coordination with standards bodies or OEM procedures. In fast-changing technical fields, these costs are recurrent rather than one-off, as content, assessment protocols and signalling mechanisms must be revised in line with evolving regulation, technology and occupational practices. Yet few mapped practices provide transparent data on how such recurrent ecosystem costs are financed over time, raising further questions about whether current delivery models are economically sustainable without continued public subsidy, collective funding mechanisms or long-term institutional support.

At European level, the Commission has taken important steps to establish open standards and shared digital infrastructures for credentials—through the Europass Digital Credentials Infrastructure (EDCI) .

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International consortia and digital credential infrastructures (e.g. Diplomasafe[19], EBSI-VECTOR[20] and the 4EU+ MICI alliance[21]) further demonstrate that once a common technical and governance backbone is in place, the marginal cost of issuing additional micro-credentials can be kept relatively low. However, these efficiencies mainly affect administrative processes, not the structural costs of high-quality provision, including teaching time, competence-based assessment, equipment, continuous curriculum updating, and outreach and guidance. As a result, while shared infrastructures significantly improve portability and trust, they do not in themselves address the core sustainability challenge of financing and maintaining high-quality technical training and robust competence assessment in rapidly evolving occupational fields.

Sustainable models depend on how recurrent costs for curriculum updating, competence-based assessment and validation are financed and governed. When these functions are embedded in recognised occupational pathways, both employers and learners are more willing to invest time—and, in some cases, fees—because individual micro-credentials contribute to credible progression and labour-market value. Providers, in turn, benefit not only from shared templates, but from common standards, assessment frameworks and coordinated update cycles. This indicates that investment in both shared digital infrastructure and pathway design can strengthen sustainability and quality simultaneously: learners gain clearer progression signals, while providers achieve economies of scale and more robust quality assurance.

For AutoCredify, the key replicable insight is that financial sustainability is inseparable from stackability, formal recognition and structured cost-sharing arrangements among providers, employers and public actors. However, sustainability must be underpinned by credible quality signals. Robust and granular data on labour-market outcomes—including job placement, task-level use of acquired skills, wage progression

[19] https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://diplomasafe.com/

[20] https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.ebsi-vector.eu/en/

[21] https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://4euplus.eu/4EU-1124.html

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and retention—are therefore critical to building trust and stimulating demand for micro-credentials as coherent pathways rather than as isolated short courses. Such transparency supports informed investment decisions by learners, who need evidence of return on time and financial commitment, and by employers, who require assurance that credentials are linked to operational performance, safety and regulatory compliance. Outcome data thus also serves as a competitive quality mechanism among providers, incentivising investment in rigorous assessment, industry alignment and pathway coherence, rather than in volume-driven course provision.

In practice, publicly subsidised micro-credentials that are embedded in coherent learning and career pathways—linking to existing VET modules, specialisation courses, or recognised industry certifications—are more likely to generate durable value than isolated short courses, even if both are initially free to the learner. While isolated courses may still play a role for rapid upskilling or awareness-raising, pathway-connected provision is more likely to support cumulative skill development, recognition, and progression over time (Cedefop, 2024)[22].

Designing pilots that leverage existing funding mechanisms (PES schemes, employer contributions, sectoral funds) while clearly articulating progression routes will therefore be central to embedding MCs in the automotive upskilling ecosystems of Spain, Portugal and Finland. MCs could be funded and communicated as 'units in a pathway', not as stand-alone courses—because recognition and progression are the main drivers of sustained learner and employer demand.

Taken together, the mapping indicates that effective micro-credential ecosystems are not built around isolated courses or digital badges, but around coherent combinations of governance, pedagogy, assessment, quality assurance and financing mechanisms that reinforce each other. Transferability does not primarily depend on replicating specific training programmes, but on replicating the *design logics* and

[22] Pouliou Aanstasia (2024) Exploring the Emergence of Micro-credentials in Vocational Education and Training (VET) Cedefop. Working paper series, No 22/June 2024

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institutional arrangements that make micro-credentials credible, usable and sustainable across different labour-market contexts.

Across the five dimensions, the most transferable mechanisms for AutoCredify are those that combine: (i) pathway-based modular design anchored in recognised occupational progression; (ii) competence-based, performance-oriented assessment supported by standardised rubrics; (iii) visible quality assurance and rich, skills-tagged digital metadata that enable verification and portability; and (iv) governance arrangements that involve public VET authorities, industry and standards bodies, and—where relevant—social partners in updating and oversight. Together, these mechanisms support not only technical interoperability, but also trust, recognition and labour-market signalling.

For the WP5 pilots, this implies prioritising the operationalisation of assessment, QA and recognition arrangements alongside curriculum design, rather than treating them as downstream implementation issues. In safety-critical domains such as EV systems and ADAS calibration, credibility depends on demonstrable task performance aligned with regulatory and industry standards, and on transparent documentation of how competence is assessed and validated. Without such arrangements, micro-credentials risk remaining formally compliant but weak as labour-market signals.

Equally, sustainability cannot be addressed through digital infrastructure alone. While shared credentialing services reduce administrative costs, the dominant cost drivers remain curriculum updating, equipped training environments, assessor capacity and moderation. Embedding micro-credentials in recognised occupational pathways, and aligning funding eligibility to assessment and recognition requirements, are therefore critical to creating incentives for both providers and employers to invest in cumulative skills development rather than disconnected short courses.

Finally, the mapping underscores the importance of transparency and outcome feedback for long-term system learning. Structured credential metadata, combined with basic labour-market outcome indicators for key target groups, can strengthen skills intelligence, support public funding decisions and encourage quality-based competition among providers. In this way, micro-credentials can function not only as training

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instruments, but as infrastructure for aligning education, employment and technological change in a rapidly evolving automotive sector.

From a scaling perspective, the pilots should therefore ideally be designed not as isolated demonstrations, but as potential testbeds for governance, assessment and funding models that can be embedded in existing national instruments—catalogues, NQFs, PES purchasing frameworks and sectoral training funds. If successful, such integration can support selective permeability between VET systems and industry certification regimes, strengthening both responsiveness to technological change and institutional trust in micro-credentials as durable components of vocational qualification architectures.

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