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# SKILLS NEEDS ANALYSIS REPORT FOR THE RENEWABLE ENERGY SECTOR

## Project 101195980 MiCRET

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# 01.

Introduction

# 1. Introduction

## 1.1 Purpose and scope

The **Skills Needs and Gaps Analysis** for Renewable Energy Technicians and adjacent roles, has the aim of informing the **MiCRET microcredential design and training strategy**. The analysis is framed around the “twin transition” (digital + green), and identifies skills as a **workplace competence mix** that combines **technical**, **digital**, **green**, **and transversal/soft skills**.

The report is written at **the EU level**: findings are used to identify *priority competence needs and recurring patterns* rather than to produce statistically representative workforce estimates or national rankings. Survey results are therefore presented descriptively, and qualitative insights are synthesized to highlight practical realities and implementation constraints.

## 1.2 Evidence base and research design (mixed-methods)

D2.1 triangulates three evidence streams:

1. **Desk research**: A structured review of policy, sectoral, and competence references (EU-level and national where relevant) to identify recurring skill signals, expected role changes, and training implications. Desk research is treated as a **first-pass evidence base** that requires validation through primary stakeholder inputs, and the report maintains a traceable link between sources, extracted skills, and implications for microcredential design.
2. MiCRET_D2.1 (1)
3. **Quantitative survey (EU-level)**: The MiCRET online survey collected **N=124** responses and is reported at EU en Q7; soft Q9), technical gaps and emerging skills (Q10–Q11 open-ended), microcredentials (Q12–Q13), and training preferences/improvement suggestions (Q14–Q15).
4. **Qualitative research (focus groups and in-depth interviews)**: Country-level and
5. EU-level stakeholder discussions add **context**, **implementation detail**, and validation of the survey and desk research signals-especially where training design requires operational specificity (e.g., what “SCADA competence” means on site, where safety gaps arise, what employers recognise, and what training formats are feasible).

## 1.3 Analytical approach (how results were handled):

**Survey analysis:**

Likert-type items are summarized using **mean (1–5)** and **Top-2 box**. Multi-select items are reported as counts and % selecting each option. Results are interpreted as **priority signals** rather than prevalence estimates. Micret_Quantitative Section_D2.1

**Open-ended synthesis:**

Non-English responses are translated into English; themes are coded as **non-exclusive** (one response may contribute to multiple themes) and reported using question-specific substantive bases (excluding "N/A / don't know / no comment"). Micret_Quantitative Section_D2.1

**Triangulation logic:**

Patterns are only treated as "robust" when they align across at least two evidence streams (desk research + survey; or survey + qualitative; etc.). MiCRET_D2.1 (1)1.4

## 1.4 Limitations (interpretation boundaries):

This report reflects (a) a **non-representative survey sample**, reached through partner outreach; (b) **geographical concentration** in some responses; and (c) varying base sizes for open-ended items. Results should therefore be read as **directional priorities** for training and microcredential design, not as EU workforce prevalence statistics.

## 1.5 Structure of the report:

**Section 2** presents desk research signals and implications for micro-credential design.

**Section 3** reports survey findings across the four skill pillars and microcredentials/training formats.

**Section 4** synthesizes qualitative findings by country and at EU level, then extracts cross-country insights.

**Section 5** translates converging evidence into recommendations for microcredential architecture, delivery formats, recognition mechanisms, and next-step implementation priorities.

# 02.

## Desk Research

# 2. Desk Research

## 2.1 Executive Summary

The desk-research findings, developed within the framework of the MiCRET project, Microcredentials for the Renewable Energy Transition, aim to address the labour shortages in the renewable energy sector through a policy experimentation focused on the adoption and recognition of microcredentials. MiCRET's overarching approach is to establish a unified European framework with common standards that enable cross-border recognition and stackable credentials, thereby supporting upskilling and reskilling pathways for renewable energy technicians and professionals. The project is implemented by a multi-country consortium, including partners from Greece, Italy, the Netherlands, Belgium, France, Germany, and Portugal, combining microcredential innovation with sectoral expertise in renewable energy.

Methodologically, the desk research was implemented as an evidence-gathering and synthesis activity undertaken once the project approach and scope were defined, reflecting a common sequencing where desk research precedes profiling and field validation. The evidence was then translated into skills and competence-oriented outputs by systematically reviewing references and indicating which skills should be included in target profiles and subsequent synthesis, supporting traceability between consulted documents and resulting competency statements. The desk research is complemented by a pan-European survey strand, "MiCRET Survey-Skills & Training Needs in the Renewable Energy Sector," which is designed to capture stakeholder input on skills and training needs and to support the validation and prioritization of competence areas identified through documentary evidence.

Across the desk-research-derived synthesis, a consistent signal is that renewable energy workforce shortages require structured and scalable upskilling responses that can be recognized and adopted across contexts, which is why MiCRET positions microcredentials as a practical mechanism for supporting labour-market responsiveness and qualification recognition. In particular, the project framing emphasizes stackability and cross-border recognition as central design principles for microcredential pathways, reflecting the need to make learning outcomes comparable and portable for technicians and professionals operating in evolving renewable energy value chains. The desk research and associated profiling logic further highlight that skills identification is not treated as an abstract taxonomy exercise but as a selection process where partners connect the evidence base to concrete skill components intended for inclusion in profiles and training modules. A further recurring direction is the intentional alignment of digital and green skills, training offers, and international recognition within modules and capacity-building initiatives, positioning the "twin" nature of competence development as an implementation requirement rather than a purely conceptual theme.

The desk research also exposes practical gaps that must be addressed through primary data collection and co-design activities, notably the need to validate which skill components stakeholders most urgently require and how those components should be packaged, assessed, and recognized within microcredential formats. In response, MiCRET's sequencing provides a clear pathway from desk research to stakeholder validation via the survey, strengthening the evidence chain that will inform subsequent microcredential design and recognition decisions within the unified European framework approach. The executive-summary positioning within the deliverable structure also supports transparency and accessibility for reviewers and stakeholders by summarizing purpose, methods, key directions, and implications before the main body of the report.

## 2.2 Desk Research Methodology

### Source Collection Strategy

The desk research was conducted collaboratively across twelve MiCRET consortium partners (AFPA, ANESPO, AZULchain, BK CONSULT, CINOP, EfVET, EVBB, L22, Learning Digital, Metropolitan College, PPC Inspectra, and WAM Foundation), each contributing sources aligned with their national and sectoral expertise. Partners were tasked with identifying relevant literature, drawing on academic databases, institutional repositories, EU policy portals, and industry publications. This distributed collection strategy ensured broad geographic coverage-spanning the European Union, individual partner countries, and selected global contexts-while capturing the diversity of perspectives that characterizes the renewable energy skills landscape.

A total of 58 sources were compiled into a shared bibliography spreadsheet. Sources were predominantly in English, reflecting the project's working language and the prevalence of English-language EU and international policy documentation.

### Inclusion and Exclusion Criteria

Sources were included if they addressed one or more of the following: skills needs, workforce development, or microcredential frameworks relevant to the renewable energy sector and the green and digital transitions. Priority was given to publications dated 2020–2025, with the majority (over 75%) published between 2023 and 2025, ensuring alignment with the current policy and labour market context.

The filtered bibliography retained sources that met at least two substantive criteria: (a) direct relevance to one of the project's target sectors-solar, wind, biomass, or the broader renewable energy field; and (b) applicability to at least one of the project's target groups, namely public authorities, industry stakeholders, technicians, trainers, learners, or investors. Sources of a purely commercial or promotional nature, those lacking identifiable authorship or institutional backing, and those falling outside the thematic scope of green and digital skills development were excluded.

### Data Extraction Fields

For each retained source, the following fields were systematically extracted and recorded:

- **Typology:** the nature of the source (e.g., publication–report, publication–journal article, publication–book, policy framework, skills forecast, database, stakeholder–industry document, best practice, employer survey, or labour market information system);
- **Sector:** the energy sub-sector addressed (solar, wind, biomass, or multiple sectors);
- **Skills category:** the type of skills covered (green, digital, green and digital, or other);
- **Target group:** the primary intended audience (public authorities, industry, technicians, trainers, learners, investors, or managers);
- **Target country/region:** geographic scope (EU-wide, multiple countries, or global);
- **Date of publication:** year of release;
- **Keywords, key topics, and key skills:** thematic descriptors enabling cross-referencing and clustering of sources.

This structured extraction enabled the consortium to map the existing evidence base along multiple dimensions-by sector, skill type, audience, and geography-and to identify both areas of concentration and gaps in the literature.

### Complementarity with Survey and Qualitative Research

The desk research constitutes the first of three complementary research strands within WP2. It establishes the baseline: a systematic mapping of what is already known about skills needs, workforce gaps, and microcredential approaches in the renewable energy sector across Europe and globally.

This evidence base directly informs the design of the project's survey instruments and qualitative interview protocols. Specifically, the thematic clusters identified through desk research-such as the persistent shortage of green-skilled workers, the emergent role of microcredentials in lifelong learning, and the uneven integration of digital competences across energy sub-sectors-serve as the conceptual scaffolding for survey question design. The qualitative strand, in turn, will explore in depth the contextual and institutional factors that published literature alone cannot fully capture, including regional implementation barriers, employer perspectives on credential recognition, and the lived experience of training providers and learners.

Together, the three strands-desk research, survey, and qualitative inquiry-form a triangulated research design that strengthens the validity and policy relevance of the analysis.

## 2.3 Skills Needs Clustering from MiCRET Desk Research (58 Sources)

### Summary

This section presents the results of a structured clustering of skills needs identified through the consortium's desk research process, in which partners reviewed references and indicated which skills should be included in the resulting profiles and synthesis. The clustering is organized into four categories (**Green**, **Digital**, **Technical**, **and Soft**) to support a transparent, meaningful and action oriented desk-research output.

## Green skills

The desk research extraction and consolidation surfaced a recurrent set of sustainability- and renewable-energy-specific competence needs that were repeatedly signalled across the reviewed references by partners during profiling.

### Most common needs

1. Energy efficiency in buildings (microcredentials in Construction - D2.1, 2024; Article 28 of the Energy Efficiency Directive, 2023; Green Skills for Green Buildings and Solar PV, 2024).
2. Solar PV installation and maintenance (Green Skills for Green Buildings and Solar PV, 2024; Renewable Energy and Jobs-Annual Review, 2024; Renewable energy benefits: Leveraging local capacity for concentrated solar power, 2025).
3. Wind turbine installation, maintenance, and safety (WindEurope Skills Outlook, 2022; WindEurope Skills Outlook, 2022; SKILLS IN THE RENEWABLE ENERGY SECTOR - Visions from the ETIPs, 2024).
4. Bioenergy/biomass production and safety (EU Skills Profile Tool - Biomass Competence, 2022; SKILLS IN THE RENEWABLE ENERGY SECTOR - Visions from the ETIPs, 2024; Green Skills in the European Labour Market, 2023).
5. Eco-construction and sustainable materials use (microcredentials in Construction, 2024; The Green Deal Industrial Plan, 2023; Greening TVET and Skills Development, 2022).
6. Sustainability literacy and environmental awareness (Green Skills in the European Labour Market, 2023; OECD: Greening Education Policies, 2021; Skills for the Green Transition, 2023).
7. Energy system integration competencies (SKILLS IN THE RENEWABLE ENERGY SECTOR-Visions from the ETIPs, 2024; Global Energy Perspective, 2024; Skills in the Renewable Energy Sector-Visions from the ETIPs, 2024).
8. Occupational adaptability and reskilling for renewables (Skills in the Renewable Energy Sector-Visions from the ETIPs, 2024; Position paper on skills..., 2024; Skills for the Green Transition, 2023).
9. Environmental and social impact assessment (Just Transition Policies..., 2023; Green Skills in the European Labour Market, 2023; Greening TVET..., 2022).
10. Low-carbon fuels and technologies competencies (Global Energy Perspective, 2024; Renewable Energy and Jobs-Annual Review, 2024; From Greenovators to Green Minds, 2023).

### Underrepresented in the evidence

The desk-research-based clustering also makes visible topics that were weakly represented or not directly elaborated in the reviewed references as recorded by partners.

- Hydrogen economy competencies.
- Offshore wind-specific technical competencies.
- Grid-scale energy storage systems (battery systems) skills.
- Life-cycle assessment and circular economy in technical practice.

## Digital skills

Across the desk research references, partners repeatedly flagged digital competencies that support both the digitalization of energy systems and the delivery/recognition of learning in microcredential formats.

### Most common needs

1. Data analysis and analytics for energy systems (Active Learning Community for Upskilling Technicians and Engineers, 2022; Training Smart Cities Professionals..., 2025; SKILLS IN THE RENEWABLE ENERGY SECTOR-Visions from the ETIPs, 2024).
2. Digital literacy and basic ICT skills (Greening TVET and Skills Development, 2022; microcredentials in Construction - D2.1, 2024).
3. AI and machine learning applications for energy (Training Smart Cities Professionals..., 2025; A microcredential approach for lifelong learning in the urban renewable energy sector, 2024).
4. Automation systems and Industry 4.0 technical digital skills (Active Learning Community..., 2022; Training Smart Cities Professionals..., 2025).
5. Cyber security for critical energy infrastructure (Active Learning Community..., 2022; Training Smart Cities Professionals..., 2025).
6. Smart systems and smart grid competencies (SKILLS IN THE RENEWABLE ENERGY SECTOR-Visions from the ETIPs, 2024; microcredentials in Construction, 2024).
7. Platform and MOOC delivery familiarity and digital pedagogy (Training Smart Cities Professionals..., 2025; microcredentials in Construction, 2024).
8. NLP and language technologies for microcredentialing (A microcredential approach for lifelong learning in the urban renewable energy sector, 2024).

### Underrepresented in the evidence

The following digital skill areas were identified as underrepresented in the desk research extraction when consolidating the partner-reported skills coverage across references.

- IoT for energy monitoring and sensors.
- Digital twins for asset management and simulation.
- Blockchain for energy markets and peer-to-peer trading.
- Cloud computing and large-scale data infrastructure.

## Technical skills

The desk research highlighted task- and occupation-oriented competences linked to installation, operation, maintenance, and production activities across renewable energy value chains, as captured through partner coding of reference materials.

### Most common needs

1. Installation and maintenance of solar PV systems (Green Skills for Green Buildings and Solar PV, 2024; Renewable Energy and Jobs-Annual Review, 2024).
2. Wind turbine installation, maintenance, and safety procedures (WindEurope Skills Outlook, 2022; WindEurope Skills Outlook, 2022).
3. Operation & Maintenance (O&M) across RE technologies (Renewable Energy and Jobs-Annual review 2021, 2021; Renewable Energy and Jobs-Annual Review 2024, 2024).
4. Project planning and system integration (Global Energy Perspective, 2024; SKILLS IN THE RENEWABLE ENERGY SECTOR-Visions from the ETIPs, 2024).
5. Biofuel production technical competencies (EU Skills Profile Tool - Biomass Competence, 2022; SKILLS IN THE RENEWABLE ENERGY SECTOR - Visions from the ETIPs, 2024).
6. Construction technical skills for eco-construction (microcredentials in Construction - D2.1 Report, 2024; microcredentials in Construction - D2.1 Report, 2024).
7. Equipment operation for hydropower and other systems (SKILLS IN THE RENEWABLE ENERGY SECTOR-Visions from the ETIPs, 2024).
8. Manufacturing and production skills for RE components (Renewable energy and jobs-Annual review 2021).
9. Smart infrastructure technical skills (automation, Industry 4.0) (Active Learning Community for Upskilling Technicians and Engineers, 2022).
10. Safety, occupational health, and compliance (Greening TVET and Skills Development, 2022; WindEurope Skills Outlook, 2022).

### Underrepresented in the evidence

When comparing the reference-derived skill signals across sectors, several technician-relevant technical domains were weakly evidenced in the extracted spreadsheet fields.

- Heat pump installation and maintenance.
- Electric vehicle charging infrastructure deployment and maintenance.
- Battery storage systems installation, integration, and maintenance.
- Grid balancing and advanced connection skills.

## Soft skills

In addition to technical and domain competences, partners' extraction from desk research sources consistently pointed to transversal skills that enable technicians to adapt to changing technologies, collaborate with stakeholders, and operate effectively in transition contexts.

**Most common needs**

1. Critical thinking and decision-making (Trends on technological changes and their impact on qualifications, 2023; Just Transition Policies..., 2023).
2. Communication and stakeholder engagement (Active Learning Community..., 2022; Training Smart Cities Professionals..., 2025; Green Skills in the European Labour Market, 2023).
3. Adaptability and lifelong learning/re-skilling orientation (A microcredential approach for lifelong learning..., 2024; Skills in the Renewable Energy Sector-Visions from the ETIPs, 2024).
4. Teamwork, collaboration, and leadership (Training Smart Cities Professionals..., 2025; Active Learning Community..., 2022).
5. Project management and planning (Just Transition Policies..., 2023; Training Smart Cities Professionals..., 2025).
6. Innovative thinking and entrepreneurship (Active Learning Community..., 2022; Greening TVET..., 2022).
7. Policy responsiveness and stakeholder negotiation (Green Skills in the European Labour Market, 2023; Greening TVET..., 2022).
8. Resilience and occupational adaptability (Greening TVET..., 2022; Green Skills in the European Labour Market, 2023).
9. Negotiation and conflict management (Greening TVET..., 2022).
10. Customer-facing and community engagement (implied but less frequent) (Greening TVET..., 2022; microcredentials in Construction, 2024).

**Underrepresented in the evidence**

The desk research sources captured in the spreadsheet were comparatively less explicit on several soft-skill domains that can be critical for implementation and uptake of renewable energy solutions in diverse contexts.

- Intercultural competence.
- Formal training in customer-facing skills for technicians.
- Community engagement methods for energy projects.
- Change management and conflict resolution.

### Cross-cutting observations

The clustering highlights that desk research can be used to connect the skill signals from references into integrated competence profiles, consistent with Erasmus+ desk research practices where partners review sources and specify which skills should be represented.

- **Strong overlap between technical and green skills**: installation and maintenance skills (solar, wind) consistently require green knowledge (energy efficiency, sustainability practices) and digital competencies (smart systems).
- **Solar and wind sectors have the richest evidence base; biomass** and hydropower are covered but less extensively, with offshore wind and storage systems weakly represented across sources.
- **Microcredential design should prioritize** modular, stackable blends combining technical tasks (installation/O&M), digital tools (data analysis, smart systems), and short assessed soft-skill modules (communication, problem-solving).
- **Geographic skew**: evidence is EU- and global-focused with limited country-specific granular data; partner countries with strong VET traditions (e.g., Germany, Netherlands) are implied but under-specified in the sources provided.
- **Evidence typology skew:** reports and policy documents dominate, with empirical employer surveys and region-specific LMI being less common, thus suggesting microcredential pilots should incorporate local employer validation.

## 2.4 Mapping Desk Research Findings to DigComp 2.2 and GreenComp

### Introduction

This section maps the skill needs identified across the MiCRET desk research corpus to two EU competence frameworks relevant to micro-credential design: DigComp 2.2 (Digital Competence Framework for Citizens) and GreenComp (European Sustainability Competence Framework). The mapping is based on the partner-led practice of extracting skills from references and indicating which skills should be included in target profiles, and it is reported transparently so the basis for each mapping decision is clear and reviewable in subsequent WP2 steps (D2.2 survey; D2.3 interviews).

### Summary

Across the desk-research-derived skill needs, digital themes most frequently cluster around handling information and data and applying digital tools to solve work-related problems, while sustainability themes most frequently cluster around systems-oriented understanding of energy transitions and practical action in technical roles. Consistent with Erasmus+ reporting conventions, this mapping should be treated as an explicit and traceable synthesis step that supports later triangulation with primary data collection rather than as a substitute for it.

## Mapping to DigComp 2.2

**Narrative analysis:**

1. **Information and data literacy-Strong support**
   The desk research synthesis repeatedly foregrounds data analysis/analytics and baseline digital literacy as core needs for energy-sector roles; these needs align directly with DigComp's focus on searching, evaluating, and managing data and information. This prominence reflects the way partners extracted and recorded skill needs from the references reviewed during desk research.

2. **Communication and collaboration-Moderate support**
   Communication, teamwork, and stakeholder engagement are recurring needs, but the desk research synthesis contains fewer explicit references to digitally mediated collaboration competences (e.g., netiquette, digital identity management) compared with more technical data- and tool-oriented needs. This indicates a moderate (rather than strong) representation when interpreted through DigComp's specific competence statements.

3. **Digital content creation-Weak support**
   The desk research synthesis includes some references adjacent to content creation (e.g., platform/MOOC delivery familiarity, occasional mentions of NLP), but there is limited explicit emphasis on programming, developing digital content, or copyright/licensing-related competences. As a result, this domain appears weakly represented in the current desk research evidence capture.

4. **Safety-Weak support**
   Cybersecurity appears as a need in parts of the desk research synthesis, but other DigComp Safety facets-such as protecting personal data and privacy and health and well-being in digital contexts-are not prominent. The overall coverage therefore remains weak at this stage and should be probed further via WP2 primary research tools.

5. **Problem solving-Strong support**
   The desk research synthesis contains repeated references to troubleshooting, system integration, automation-related competencies, and transversal problem-solving skills (e.g., critical thinking and decision-making). These needs map well to DigComp's competence statements on solving technical problems and creatively using digital technologies to address needs and gaps.

## Mapping table

The table below provides an indicative "skill need → DigComp domain" mapping derived from the desk-research skill extraction and synthesis process; the "Evidence Strength" column should be read as a working assessment to be validated through later triangulation.

| Desk Research Skill Need | DigComp 2.2 Domain | DigComp Competence | Evidence Strength |
|---|---|---|---|
| Data analysis and analytics for energy systems | Information and Data Literacy | Evaluating; Managing data and files | Strong |
| Digital literacy and basic ICT skills | Information and Data Literacy | Browsing, searching and filtering; Managing data | Moderate |
| Platform and MOOC delivery familiarity / digital pedagogy | Communication and Collaboration | Collaborating; Interacting | Moderate |
| NLP and language technologies for microcredentialing | Digital Content Creation | Developing digital content; Integrating content | Weak |
| AI and machine learning applications for energy | Problem Solving | Creatively using digital technologies; Identifying needs | Moderate |
| Automation systems / Industry 4.0 digital skills | Problem Solving | Solving technical problems; Identifying technological responses | Strong |
| Cyber security for critical energy infrastructure | Safety | Protecting devices; Protecting personal data and privacy | Moderate |
| Smart systems and smart grid competencies | Problem Solving | Identifying needs; Solving technical problems | Strong |
| Digital twins/simulation (underrepresented) | Digital Content Creation | Programming; Integrating content | Weak |
| IoT for energy monitoring (underrepresented) | Information and Data Literacy | Browsing, searching and filtering; Managing data | Weak |
| Cloud computing & data infrastructure (underrepresented) | Information and Data Literacy | Managing data and files | Weak |
| Digital pedagogy for MOOCs | Communication and Collaboration | Sharing; Collaborating | Moderate |
| Protecting health and well-being in digital contexts (rare) | Safety | Protecting health and well-being | Weak |
| Managing digital identity and netiquette (rare) | Communication and Collaboration | Managing digital identity and netiquette | Weak |
| Basic programming for energy tools (rare) | Digital Content Creation | Programming | Weak |

## Mapping to GreenComp

**Narrative analysis:**

1. **Embodying sustainability values-Moderate support**
   Sustainability literacy and environmental awareness feature in the desk research synthesis and align with valuing sustainability and promoting nature; however, explicit articulation of fairness/justice-oriented competences is less prominent in the extracted skill statements. On this basis, the current evidence capture supports a moderate mapping to this domain.

2. **Embracing complexity in sustainability-Strong support**
   Systems-level themes (e.g., energy system integration, environmental and social impact assessment, and framing challenges for VET alignment) are recurrent in the skill synthesis. These themes closely reflect systems thinking and critical thinking competences, making this domain strongly represented in the desk research mapping.

3. **Envisioning sustainable futures-Weak support**
   The desk research synthesis contains limited explicit emphasis on futures literacy, anticipatory thinking, or exploratory scenario competences as training outcomes. Where foresight is present, it tends to appear as contextual labor-market or sector foresight rather than as competence-oriented curriculum requirements, resulting in weak representation in the current mapping.

4. **Acting for sustainability-Moderate support**
   Many extracted needs relate to implementation-oriented technical practice (e.g., installation, operation and maintenance, and eco-construction), and policy and partnership documents emphasize upskilling/reskilling and structured initiatives. However, competencies in collective action and political agency are less explicit in the extracted skills, leading to a moderate overall mapping at this stage.

### Mapping table

The table below provides an indicative "skill need → GreenComp domain" mapping derived from the desk-research skill extraction and synthesis process, reported in a way that supports transparent review and later triangulation with survey and interview findings.

| Desk Research Skill Need | GreenComp Domain | GreenComp Competence | Evidence Strength |
|---|---|---|---|
| Energy efficiency in buildings | Embracing Complexity in Sustainability | Systems thinking; Problem framing | Strong |
| Solar PV installation and maintenance | Acting for Sustainability | Individual initiative; Practical implementation | Strong |
| Wind turbine installation and maintenance | Acting for Sustainability | Practical implementation; Individual initiative | Strong |
| Bioenergy/biomass production and safety | Embracing Complexity in Sustainability | Systems thinking; Problem framing | Moderate |
| Eco-construction and sustainable materials use | Acting for Sustainability | Individual initiative; Practical implementation | Strong |
| Sustainability literacy and environmental awareness | Embodying Sustainability Values | Valuing sustainability; Promoting nature | Strong |
| Energy system integration competencies | Embracing Complexity in Sustainability | Systems thinking; Problem framing | Strong |
| Occupational adaptability and reskilling | Envisioning Sustainable Futures | Adaptability; Futures literacy (implicit) | Moderate |
| Environmental and social impact assessment | Embracing Complexity in Sustainability | Systems thinking; Critical thinking | Strong |
| Low-carbon fuels and technologies competencies | Embracing Complexity in Sustainability | Systems thinking; Problem framing | Moderate |
| Circular economy and life-cycle assessment (underrepresented) | Envisioning Sustainable Futures | Exploratory thinking; Futures literacy | Weak |
| Hydrogen economy competencies (underrepresented) | Acting for Sustainability | Individual initiative; Collective action | Weak |
| Offshore wind-specific technical competencies (underrepresented) | Acting for Sustainability | Practical implementation | Weak |
| Grid-scale storage systems (underrepresented) | Embracing Complexity in Sustainability | Systems thinking; Problem framing | Weak |
| Policy responsiveness and stakeholder negotiation | Acting for Sustainability | Collective action; Political agency | Moderate |

### Underrepresented domains and evidence gaps

For DigComp, the current desk-research skill synthesis most clearly underrepresents Digital Content Creation and parts of Safety and Communication and Collaboration. In particular, the extracted skill needs provide limited explicit grounding for programming, copyright/licensing, sustained content creation practice, protecting personal data and privacy, and digital wellbeing, as well as netiquette and managing digital identity; these omissions should be made explicit to keep reporting clear and to avoid over-claiming framework coverage in microcredential specifications.

For GreenComp, the current desk-research skill synthesis provides weaker explicit coverage for parts of Embodying Sustainability Values (especially fairness/justice) and Envisioning Sustainable Futures (futures literacy and exploratory thinking), and only moderate coverage for the collective-action and political-agency aspects of Acting for Sustainability. Making these gaps explicit strengthens the transparency of the deliverable and supports targeted follow-up through WP2 primary research instruments.

### Implications for microcredential design

The mapping suggests that MiCRET microcredentials can most confidently align learning outcomes to DigComp domains focused on information/data handling and problem solving and to GreenComp domains focused on embracing complexity and acting for sustainability, because these areas are most consistently reflected in the desk-research-extracted skill needs. At the same time, the D2.2 survey should explicitly probe needs in the underrepresented DigComp and GreenComp areas (e.g., content creation and broader safety competences; futures literacy and collective/political agency), and D2.3 interviews should test how employers and providers interpret and assess these competences in practice, while keeping documentation and reporting explicit about what each module covers.

## 2.5 Desk Research Synthesis: Trends and Drivers

### Desk Research Synthesis

The desk research strand was designed to provide a structured evidence base on renewable energy sector (RES) labour market developments and the resulting skills implications before validating and deepening findings through primary data collection in subsequent WP2 tasks. In line with common Erasmus+ reporting conventions, desk research outputs are expected to make their logic transparent, including clear referencing of consulted documents and a coherent narrative that connects evidence to conclusions relevant for later work packages. The synthesis below therefore focuses on patterns that are visible in the consortium bibliography (e.g., repeated attention to shortages, digital transformation, and the “twin transition”), and on how these patterns translate into skill demand areas that can be operationalized in microcredential design.

## Labour Market Pressures and Shortages in the Renewable Energy Sector

Across the MiCRET desk research bibliography, labour market pressure appears as a recurrent organizing theme, reflected by the inclusion of sources explicitly framed around shortages, employment trends, and skills gaps in clean energy value chains (e.g., "Persistent lack of skilled workers could threaten EU clean energy transition" (2023), "Renewable Energy and Jobs – Annual Review 2024" (2024), and "2025 Global Energy Talent Index" (2025)). The dataset combines EU-facing evidence (e.g., sectoral skills analyses and policy-aligned reports) with global outlooks, signalling that workforce constraints are treated as both a European implementation risk and a globally competitive challenge for attracting technicians and engineers.

A second visible pattern is that shortages are not presented as uniform across the RES, but instead cluster around specific sub-sectors and occupational task bundles, which is consistent with the presence of sector-specific sources for solar PV, wind, and biomass competencies. For solar PV, the bibliography includes forward-looking employment and jobs reporting (e.g., "EU Solar Jobs Report 2024" (2024)) and training-oriented analyses of workforce shortage and participation barriers (e.g., "Green Skills for Green Buildings and Solar PV" (2024)). For wind, the inclusion of "WindEurope Skills Outlook 2022" (2022) indicates that technical profiling (installation, maintenance, safety) is treated as a core evidence component for identifying bottlenecks in technician supply and practical training capacity.

The bibliography also contains tools and reports that focus on competence definition and skills signalling, such as "EU Skills Profile Tool – Biomass Competence" (2022), implying that the skills gap is addressed not only via aggregate employment counts but also through the standardization of task- and competence-level descriptions that can be translated into training outcomes. Finally, the inclusion of regionally comparative analyses (e.g., "SEED Skills Analysis Report-Shaping Skills for Energy Transition in Five European Regions" (2023)) and longer-horizon outlooks (e.g., "Skills in Transition-the way to 2035" (2023); "Future of Work 2025" (2025)) signals that MiCRET's desk research treats skills gaps as structurally persistent, geographically uneven, and likely to intensify as deployment accelerates rather than as a short-term fluctuation.

## Drivers of Digitalization

Digitalization is treated in the desk research corpus as a direct driver of changing skills profiles for RES technicians, rather than as a purely "training delivery" issue, as shown by the repeated emphasis on automation, smart systems, and data-centric work practices in included sources. Notably, the skills clustering derived from the bibliography prioritizes "Data analysis and analytics for energy systems," "Automation systems and Industry 4.0 technical digital skills," and "Smart systems and smart grid competencies," indicating that monitoring, control, and optimization functions are increasingly embedded in technician roles and therefore need to be reflected in microcredential learning outcomes.

The bibliography further suggests that AI and advanced analytics are entering the skills discourse in two distinct ways: as emerging technical capabilities for energy systems (e.g., "SKILLS IN THE RENEWABLE ENERGY SECTOR-Visions from the ETIPs" (2024)) and as enabling technologies within training and credentialing ecosystems (e.g., "A microcredential approach for lifelong learning in the urban renewable energy sector" (2024), which is included under micro-certification and stakeholder-linked approaches). This dual positioning matters for MiCRET because it points to the need to design microcredentials that cover both (i) operational digital competencies for technicians and (ii) the digital affordances of modular training pathways (platform-based delivery, assessment workflows, and recognition mechanisms).

Cybersecurity emerges as a specific and non-substitutable digital competence area, as reflected in the clustering output that repeatedly identifies "Cybersecurity for critical energy infrastructure" in sources concerned with upskilling technicians and engineers and with Industry 4.0/5.0 skill sets (e.g., "Active Learning Community for Upskilling Technicians and Engineers" (2022); "Training Smart Cities Professionals on Digital and Horizontal Skills in the Industry 5.0 Era" (2025)). At the same time, the desk research evidence base appears to treat certain frontier digital areas (e.g., IoT sensing architectures, digital twins, cloud-based data infrastructures) as underrepresented, suggesting that MiCRET's primary research instruments should explicitly test whether these topics are emerging employer requirements in partner regions or remain niche capabilities in the near term.

## Drivers of Green Transition

The green transition drivers in the desk research bibliography are anchored in policy and regulatory demands that translate decarbonization objectives into concrete training and certification requirements, as reflected by the inclusion of EU policy-linked sources such as "Article 28 of the Energy Efficiency Directive" (2023) and industrial policy measures such as "The Green Deal Industrial Plan" (2023). The skills clustering reinforces that energy efficiency in buildings and eco-construction practices are prominent, indicating that building-related energy performance, sustainable material choices, and compliance-oriented practice are treated as high-priority competence areas connected to decarbonization delivery pathways.

The bibliography also indicates that green transition drivers are framed through sector-wide transition scenarios and investment/deployment outlooks (e.g., "Global Energy Perspective 2024" (2024); "Renewable Energy and Jobs-Annual Review 2024" (2024)), which are used in MiCRET not as deterministic forecasts but as contextual evidence supporting the scale and pace assumptions behind workforce planning and modular upskilling strategies. In parallel, the presence of construction-focused microcredential ecosystem work (e.g., "microcredentials in Construction – D2.1 Report with analysis of a Green Skills microcredentialing ecosystem" (2024) and "microcredentials in Construction – ESCO's green labels for skills in the construction sector" (2024)) suggests that sustainability compliance is increasingly operationalized via competence frameworks, labels, and quality assurance mechanisms, which can be aligned with stackable microcredentials.

Finally, the inclusion of sources addressing just transition considerations (e.g., "Just Transition Policies, Power Plant Workers and Green Entrepreneurs in Greece, Cyprus and Bulgaria" (2023)) indicates that the green transition is treated not only as a technical deployment challenge but also as a socio-economic transformation requiring assessment of environmental and social impacts and the reskilling of workers from declining fossil-based sectors.

## From Drivers to Skills Demand

Taken together, the labour market pressures, digitalization dynamics, and policy-driven decarbonization agenda translate into a convergent skills demand profile that is best understood through the four-cluster model (Green, Digital, Technical, Soft) produced from the desk research dataset. First, the “Green” cluster is dominated by applied competencies that link sustainability goals to day-to-day technical practice, especially energy efficiency in buildings, eco-construction and sustainable materials, and sector-specific renewable competencies (solar PV, wind, biomass), alongside sustainability literacy and environmental awareness as enabling knowledge for compliant, safe, and quality-assured work. The explicit identification of underrepresented green areas (hydrogen economy competencies, offshore wind, grid-scale storage, life-cycle assessment) is analytically useful because it provides an evidence-based hypothesis set for validation through the survey and interviews, rather than treating “green skills” as an undifferentiated category.

Second, the “Digital” cluster indicates that technician roles increasingly require competence in data handling, automation, and smart systems, with cybersecurity standing out as a critical infrastructure requirement; however, the weak coverage of advanced domains (IoT, digital twins, cloud) points to a potential lag between leading-edge technological narratives and the competences currently articulated in widely used training and policy documents. Third, the “Technical” cluster remains centered on installation, operation, maintenance, safety, and system integration tasks across technologies, indicating that microcredentials must keep a strong practical orientation and be closely mapped to occupational task profiles (e.g., wind maintenance and safety, solar PV installation, and O&M across technologies).

Fourth, the “Soft” cluster shows that transversal competences are not optional add-ons but are repeatedly connected to effective reskilling, project delivery, and stakeholder-facing work in complex transition contexts, including critical thinking, decision-making, communication, adaptability, teamwork, and project management. This supports a design implication for MiCRET: microcredentials should be modular and stackable, but also deliberately integrated-pairing short, assessable technical units with digital tool use and targeted transversal skills relevant to technicians’ real work settings (e.g., troubleshooting, safety communication, coordination with other trades).

In practical terms, the desk research also reinforces the role of microcredentials as an implementation mechanism for rapid upskilling and reskilling, as suggested by the presence of EU framework material (“Building a European Approach to microcredentials” (2021)) and sector-relevant microcredential exemplars (e.g., “A microcredential approach for life-long learning in the urban renewable energy sector” (2024); “Upskilling the workforce for Green transition” (2024)). To maximize transferability and recognition across partner countries, the resulting MiCRET microcredential specifications should maintain the same transparency principles applied in desk research reporting-clear documentation of learning outcomes, assessment logic, and the evidence basis used to justify competence selection-so that stakeholders can interpret and compare credential content consistently.

## 2.6 Cross-Country Comparative Analysis and Dataset Limitations

This section examines the MiCRET desk research bibliography (n=58) through the lens of partner contributions and geographic/thematic coverage, identifying patterns in how different consortium members and their national contexts shaped the evidence base. It concludes with a candid assessment of the dataset's limitations and their implications for subsequent primary research.

### Comparative Observations

1. **Policy vs industry vs VET emphases across partners**: The bibliography shows a clear division of labour. L22 (Italy) and ANESPO (Portugal) prioritize policy frameworks and institutional instruments (Energy Efficiency Directive, Green Deal Industrial Plan, EU microcredentials framework) while BK CONSULT (Germany) and AFPA (France) submit employer-facing evidence (Global Energy Talent Index; AFPA position papers and sectoral job reviews) that foreground labour market demand and skills shortages. EfVET and CINOP largely contribute VET-oriented foresight and alignment materials (SEED, SECOVE, and Cedefop forecasts), positioning them as the consortium's VET capacity specialists. This distribution indicates complementary strengths but also potential gaps where policy, employer demand, and VET responses need closer integration (e.g., employer data feeding into VET alignment).

2. **Geographic aggregation reduces national granularity**: Most sources target the EU or global scales (numerous 'European Union' or 'All countries' target_country entries across LD, AFPA, EfVET, BK CONSULT). This creates an EU-aggregate evidence base that is current and comparable but weak on national particularities. The consortium's multi-country composition is not mirrored by equally distributed national studies; only a few items offer country-level case studies (Metropolitan College's just transition case studies). For microcredential design, this means that while pan-EU trends are well supported, local employer expectations and regulatory details may be under-specified.

3. **Sectoral skew**: breadth over depth: 'Multiple sectors' is the dominant sector tag across entries (a majority of the 58 sources), producing strong cross-sectoral synthesis capacity but uneven sub-sectoral coverage. Solar has dedicated reports (AFPA, LD), wind is represented but less extensively (ANESPO, EfVET), and biomass appears narrowly (ANESPO biomass tool). Offshore wind, hydrogen, and storage-related technical domains are weak or absent. Consequently, microcredential modules for widely studied sectors (solar, general renewables) can be evidence-based, but specialized modules (offshore wind, battery storage) will require primary data collection.

4. **Digital skills are unevenly represented and concentrated**: Explicit digital/Industry 4.0 and Industry 5.0 content is concentrated in Metropolitan College and EVBB contributions (Active Learning Community, Training Smart Cities Professionals, ETIP visions). While many sources acknowledge digitalization as part of the 'twin transition', few provide detailed competence lists for technicians (IoT, digital twins, and cloud architectures are underrepresented). This suggests the desk research establishes the importance of digital skills but lacks deep, operational detail needed to construct advanced digital microcredentials.

5. **Soft skills are present but inconsistently treated**: Soft/transversal skills (communication, critical thinking, and adaptability) appear prominently in Metropolitan College and in several UNESCO/Greening TVET guidance materials (PPC Inspectra), but are peripheral in many industry reports that prioritize technical shortages (BK CONSULT, AFPA). The result is conceptual recognition of soft skills but limited operationalization (few sources specify assessment approaches or training durations), which complicates design of assessed soft-skill microcredentials without further qualitative validation.

6. **microcredential cluster vs traditional skills evidence**: A coherent cluster of sources explicitly addressing microcredentials and validation (ANESPO, AZULchain, AFPA, PPC Inspectra, WAM F., LD) provides frameworks and curricular guidance. However, many labour-market and forecasting sources (IRENA, McKinsey, WEF, Global Energy Talent Index) do not bridge to credentialing mechanisms. This divide means WP3 cannot rely solely on labour market reports to specify credential structures-linkage work and stakeholder validation will be required.

7. **Temporal concentration and evidence-type imbalance**: The literature is recent (majority 2023–2025), offering currency but fewer long-term historical baselines. Evidence types skew toward reports and policy documents; primary employer surveys and sub-national labour market information are relatively scarce (notwithstanding LD's inclusion of databases like EURES and Cedefop tools). For rigorous module validation, MiCRET will need to supplement with employer surveys (D2.2) and qualitative interviews (D2.3) to obtain granular LMI and employer priorities.

8. **Implication for consortium research sequencing**: Given the dataset's strengths (EU-level policy, forecasting, microcredential frameworks) and weaknesses (national granularity, digital/technical depth, employer primary data), the consortium should prioritize (a) using desk research to draft initial competency frameworks and microcredential prototypes, (b) conducting targeted employer surveys in under-represented sub-sectors/geographies, and (c) using qualitative interviews to operationalize soft and advanced digital competencies for assessment and stackability design.

## Limitations of the Desk Research Dataset

1. **Dominance of 'Multiple sectors' classification**: The majority of the 58 sources are labelled 'Multiple sectors', which reduces sub-sectoral specificity. This limits the desk research's ability to provide fine-grained, sector-specific competency requirements (e.g., offshore wind, battery storage). Because many entries aggregate across technologies, conclusions about detailed technical skills must be treated as indicative and will require primary data collection to validate sub-sector training needs.

2. **Lack of nationally specific evidence**: Most sources target the EU or global level rather than specific partner countries. This means the dataset is strong for pan-EU policy and forecasting, but weak for national regulatory detail, employer practices, apprenticeship systems, and local VET provision. As a result, microcredential recognition and pilot design will need additional national-level LMI and stakeholder engagement.

3. **Limited employer/primary data**: Employer surveys and primary labour market evidence are under-represented: only a small number of employer-facing surveys and a limited set of LMI databases appear (e.g., Future of Work employer surveys in LD; Global Energy Talent Index). The scarcity of primary employer data constrains direct translation of reported skills shortages into validated, employer-endorsed competency profiles. Targeted D2.2 surveying is therefore essential.

4. **Underrepresentation of specific technical domains**: Key emerging technical areas-hydrogen economy, heat pump installation, battery storage systems, offshore wind installation and grid balancing-are weakly represented or absent. This gap constrains evidence-based design for microcredentials in these growing technical fields and necessitates targeted primary research and consultation with sectoral employers and ETIPs.

5. **Limited coverage of informal/non-formal learning pathways and recognition mechanisms**: While EU microcredential frameworks and toolkits are present, evidence on informal/non-formal learning recognition, employer-led credentialing, and local practices is limited. This constrains understanding of stackability, recognition, and uptake barriers in practice; D2.2 and D2.3 should explicitly probe informal learning routes and employer recognition practices.

## 2.7 Preliminary Conclusions from Desk Research

### What the Literature Consistently Signals

The desk research strand is designed to translate existing references into an initial, evidence-informed picture of the skills landscape by systematically reviewing relevant documents and extracting skills that should be reflected in occupational or training profiles. Across this approach, the literature base is treated as a structured input to subsequent WP2 activities and to the deliverable narrative, in line with Erasmus+ reporting conventions that require an introduction, a main analytical part, and conclusions where relevant. Within the reviewed evidence, partners consistently used the references to identify skills to be included, suggesting that recurring signals in the literature can be aggregated into shared, cross-partner priorities rather than being interpreted on an ad hoc basis. As a result, the desk research provides a baseline that is sufficiently stable to inform downstream instrument design, while recognizing that the evidence base is constrained by what is explicitly captured in the consulted references and how transparently those references are documented.

### How Demand Clusters into Four Skill Categories

The desk research extraction approach enables the consortium to organize identified skills into an interpretable clustering logic that can be used to structure both analysis and microcredential design choices, because partners explicitly indicate "which skills ... should be included" when processing each reference. In operational terms, this supports a four-cluster framing (Green, Digital, Technical, Soft) as an analytical device for summarizing the literature and comparing patterns across sectors and stakeholders, provided the consortium maintains clear and consistent naming of documents and referenced items across the dataset. This clustering also supports transparency and reuse: by making the skills identification step explicit at the level of each reference, the consortium can later trace survey and interview items back to the desk-research evidence base, strengthening the methodological chain between sources, extracted skills, and proposed training responses. Finally, using a consistent structure helps ensure that skills clustering is presented coherently alongside the overall project rationale and subsequent conclusions, rather than remaining an isolated analytical exercise.

### What Is Missing and Will Be Addressed by Primary Research

Because desk research depends on what is available and reported in the underlying references, it can systematically surface "what is present" but may under-capture practice-based needs that are not well documented or not comparably documented across countries and sectors. For this reason, the consortium's primary research (survey and interviews) is required to validate, contextualize, and complete the desk-research picture, particularly where desk research yields strong signals but limited operational detail for training design and assessment. In addition, ensuring clarity in document naming and referencing is not only a reporting requirement, but also a practical mitigation for desk-research gaps, as it reduces ambiguity when translating desk-research insights into instruments and later into microcredential specifications.

### Implications for WP3 microcredential Design

The desk research supports several immediate design implications for WP3, on the condition that the consortium preserves a transparent audit trail from references to extracted skills and to learning outcomes. These implications are:

1. **Prioritize twin-transition modules** by using desk-research-derived skills clusters as an organizing logic for module bundles, ensuring the underlying references are clearly documented to justify each bundle.
2. **Anchor in EU competence framework**s by aligning the module specification format with Erasmus+ deliverable conventions (clear structure, explicit conclusions) and by documenting the evidence trail linking references to intended competences.
3. **Build sector-specific technical modules** by using the desk research step to identify which skills recur across references and then testing sectoral specificity through primary research where references are less explicit.
4. **Integrate assessed soft skill**s by translating skills identified from references into assessable learning outcomes, and verifying assessment feasibility and relevance through qualitative work where desk research is not sufficiently detailed.
5. **Design for employer validation** by treating desk research as a first-pass evidence base that must be confirmed with stakeholders through the survey and interviews, maintaining a clear linkage between referenced documents, extracted skills, and final module choices.

# 03.

## Quantitative Research and Analysis

# 3. Quantitative Research and Analysis

## 3.1 Purpose and survey structure

The MiCRET online survey collected **N=124** submitted responses and is reported at **EU level**
(descriptive; not a country-by-country comparison).

This chapter reports the **quantitative findings** of the MiCRET online survey on s**kills and training needs for Renewable Energy Technicians**, structured in four blocks:

1. **Participant profile (Q1–Q5)**: **single-choice items describing role, RES field**, **country of operation**, **experience**, **and organization type**.
2. **The importance of skills** for technicians is split into **Digital (Q6)**, **Green (Q7)**, plus **Soft skills (Q9)** and **Technical skills (Q10–Q11, open-ended)**.
3. **microcredentials (Q12–Q13)**: **awareness (Q12) and agreement ratings (Q13) among those familiar.**
4. **Training formats & feedback** (Q14–Q15)

### Quantitative analysis approach

- Likert items are summarized using mean score (1–5) and **Top-2 box** (Q6–Q7: *Much/Very much in need*; Q13: *Agree/Strongly agree*).
- Multi-select items (Q14) are reported as the number and % of respondents selecting each format.
- Results are presented descriptively to support an EU-level skills needs picture and will be triangulated with desk research and qualitative work (focus groups/interviews) per the research protocol logic already described in the chapter introduction.

### Qualitative coding approach (open-ended questions)

- Non-English responses were translated into English for synthesis.
- Responses were grouped into themes; themes are non-exclusive (one response can contribute to multiple themes).
- Open-ended questions were coded using **question-specific ‘substantive’ bases** (excluding ‘No/N/A/don’t know’ replies). Bases vary by question (e.g., Q8≈93, Q10=97, Q11=97, Q15≈93).

## Limitations (how to interpret the results)

- **Non-representative sample:** results should be treated as **indicative** of priorities among participants reached through partner outreach, not as EU workforce prevalence estimates.
- **Geographical concentration:** responses are concentrated in **Portugal and Italy (64.6% combined)**, so national patterns are not inferred, and results are aggregated at EU level.
- **Base sizes:** open-ended items vary in the number of substantive responses.
- **Open-ended synthesis:** thematic results reflect interpretation of respondent language; reporting emphasizes **recurring patterns** rather than exhaustive enumeration.

## Key findings from the survey

- **Digital skills priorities (Q6):** the strongest needs relate to **learning agility,** plus operational digital capability (data analysis for performance monitoring, SCADA/monitoring systems, and IoT/ sensors).
- **Green skills priorities (Q7):** green needs are anchored in **energy efficiency optimization** and **compliance/safety**, followed by impact-aware daily practice and systems thinking.
- **Soft skills profile (Q9)**: respondents converge on an **"adaptive problem solver"** profile (flexibility/adaptability + problem solving), supported by collaboration/communication and critical thinking.
- **Technical gaps and near-term frontier (Q10–Q11)**: today's gaps emphasize **system integration, advanced troubleshooting, monitoring/control proficiency, grid and storage readiness**; emerging needs point to **AI-enabled maintenance/optimization, storage-centric systems, smart grids, interoperability, and cybersecurity**.
- **microcredentials (Q12–Q13)**: awareness is not yet mainstream (only a minority report familiarity), but the "aware" subgroup views microcredentials as useful-while perceived recognition in recruitment/promotion is weaker than perceived usefulness.
- **Training delivery (Q14–Q15)**: preferences and suggestions consistently prioritize **work-based learning and blended approaches**, with strong demand for **hands-on practice**, integrated digital tooling, and modular/stackable delivery with credible assessment and certification.

## 3.2 Presentation of findings

### Survey Section 1: Participant profile and demographics (Q1–Q5)

This section provides a concise overview of "who answered" (not a country-by-country analysis).

#### Question 1

**"What is your current professional role?"**

Q1 captures the **stakeholder perspective** represented in the survey (e.g., technicians and engineers from practice, employers and managers from workforce planning, and VET/cVET actors from the training ecosystem). In a skills needs analysis, understanding "who answered" is essential to interpret results as **demand-side** (industry) and **supply-side** (education/training) signals. Roles were harmonized into consolidated stakeholder groups (N=124), reflecting both **workplace practice** and the **training ecosystem** relevant to Renewable Energy Technicians.

**Q1. Results (n=124)**

Regarding their professional role, respondents of this survey were primarily:

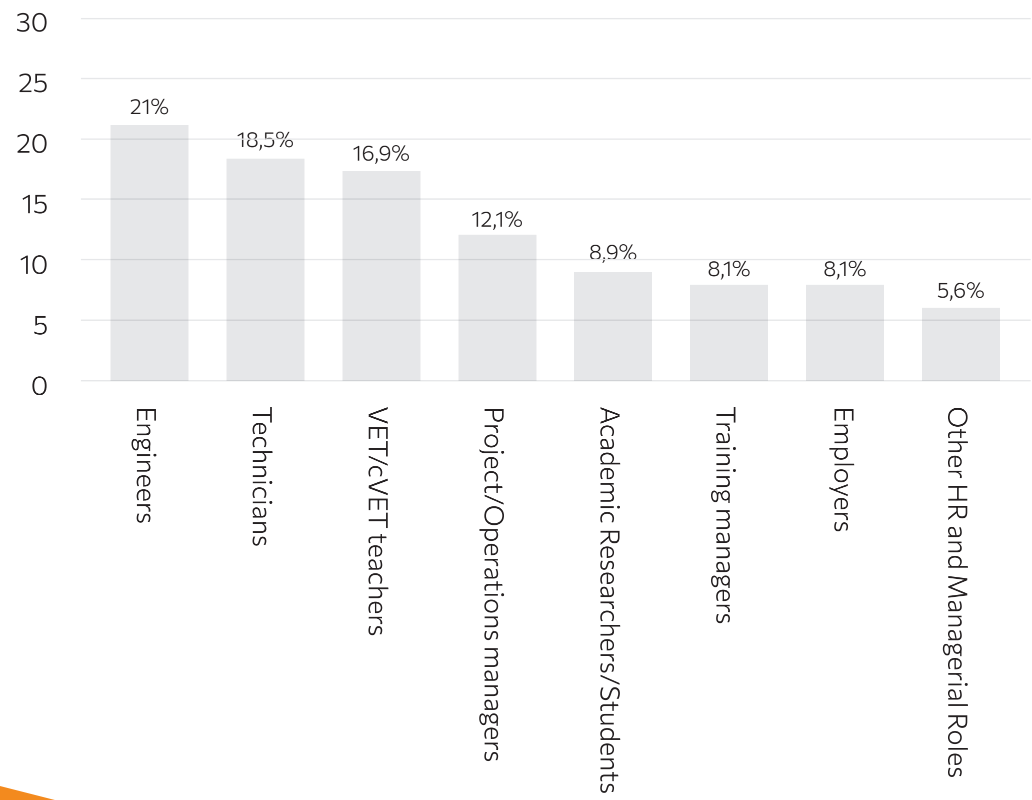
1. **Engineers**: 26 (21%)
2. **Technicians**: 23 (18.5%)
3. **VET/cVET teachers**: 21 (16.9%)
4. **Project/Operations managers**: 15 (12.1%)
5. **Academic Researchers/Students**: 11 (8.9%)
6. **Training managers**: 10 (8.1%)
7. **Employers**: 10 (8.1%)
8. **Other HR and Managerial Roles**: 7 (5.6%)
9. **Other**: 1 (0.8%)

| Q1. Professional role of respondents | n | % (of n=124) |
|---|---|---|
| Engineers | 26 | 21% |
| Technicians | 23 | 18.5% |
| VET/cVET teachers | 21 | 16.9% |
| Project/Operations managers | 15 | 12.1% |
| Academic Researchers/Students | 11 | 8.9% |
| Training managers | 10 | 8.1% |
| Employers | 10 | 8.1% |
| Other HR and Managerial Roles | 7 | 5.6% |
| Other unspecified | 1 | 0.8% |

### Q1. Results synopsis

Overall, the survey reflects a **multi-stakeholde**r view of renewable energy technician skills needs. Technical practitioners (**engineers and technicians: 39.5% combined**) form the largest segment, ensuring the findings are grounded in operational realities. At the same time, the training ecosystem is strongly represented (**VET/cVET teachers and training managers: 25.0% combined**), supporting the relevance of conclusions for training design and delivery (including microcredentials and modular approaches). The presence of **project/operations managers and employers (20.2% combined)** adds an organizational and workforce-planning perspective, supporting the EU-level prioritization of skills that matter for performance, safety, and scalability of RES deployments.

### Q1. Professional role of respondents



## Question 2

**"Which Renewable Energy System (RES) are you mainly involved in?"**

**Q2** captures the main **technical/sectoral context** of respondents' work (e.g., Solar PV, Wind, Hydrogen, systems integration). In a skills needs analysis, this profile helps interpret later results because different RES fields place different emphasis on skills (e.g., monitoring/SCADA in operational environments, safety and compliance in fieldwork, or integration skills in hybrid systems). In this report, Q2 is used **descriptively** to contextualize the EU-level findings (not to compare sub-sectors).

### Q2. Main RES field (n=124) Results

The most represented areas were:

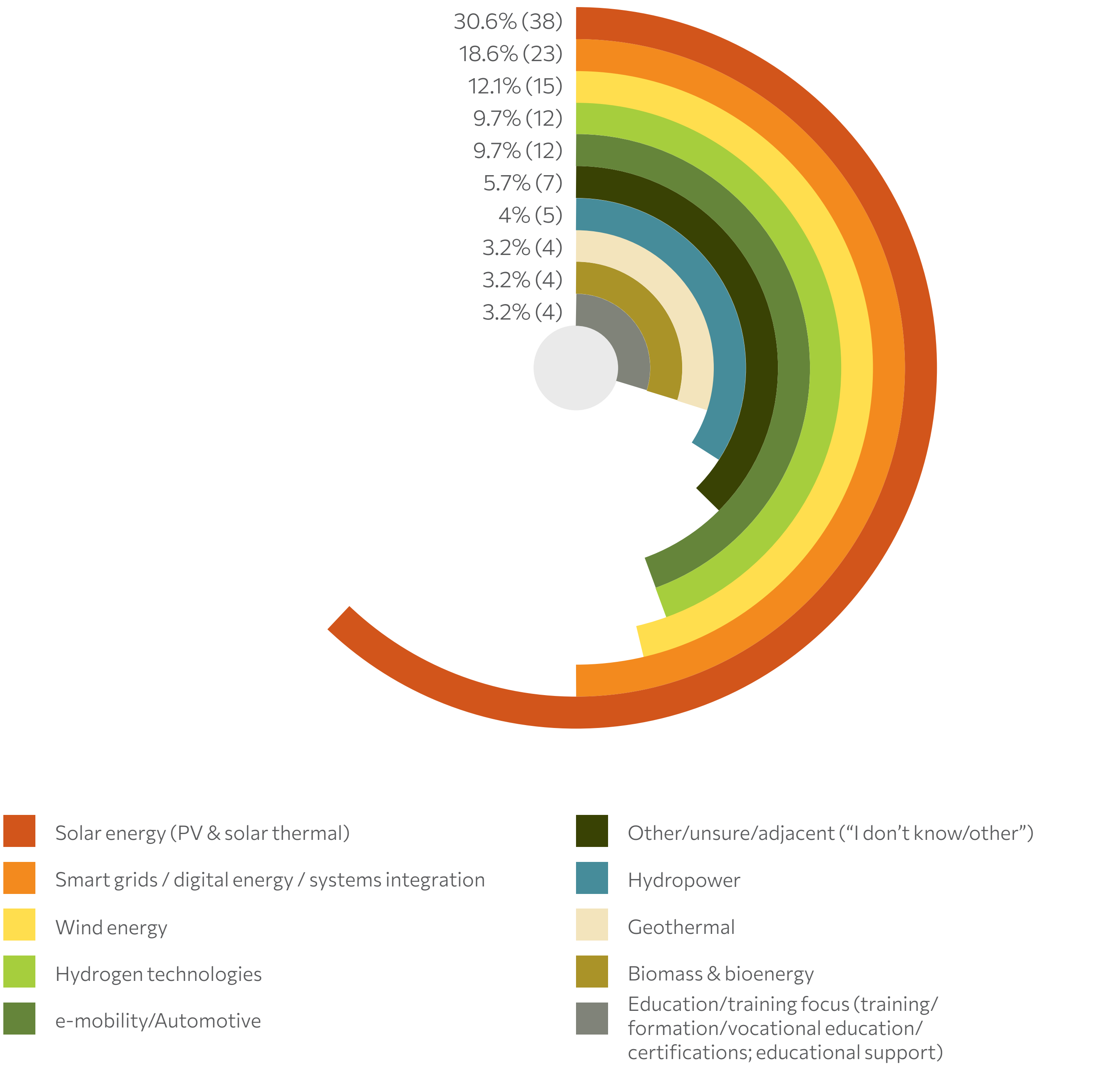
1. Solar energy (PV & solar thermal): 38 (30.6%)
2. Smart grids / digital energy / systems integration: 23 (18.5%)
3. Wind energy: 15 (12.1%)
4. Hydrogen technologies: 12 (9.7%)
5. e-Mobility / Automotive: 12 (9.7%)
6. Hydropower: 5 (4.0%)
7. Geothermal: 4 (3.2%)
8. Biomass & bioenergy: 4 (3.2%)
9. Education/training focus: 4 (3.2%)
10. Other: 7 (5.6%)

| Q2. RES Representation | n | % (of n=124) |
|---|---|---|
| Solar energy (PV & solar thermal) | 38 | 30.6% |
| Smart grids / digital energy / systems integration | 23 | 18.6% |
| Wind energy | 15 | 12.1% |
| Hydrogen technologies | 12 | 9.7% |
| e-mobility/Automotive | 12 | 9.7% |
| Other/unsure/adjacent ("I don't know/other") | 7 | 5.7% |
| Hydropower | 5 | 4% |
| Geothermal | 4 | 3.2% |
| Biomass & bioenergy | 4 | 3.2% |
| Education/training focus (training/formation/vocational education/certifications; educational support) | 4 | 3.2% |

## Q2. Results synopsis

- The largest share of respondents work in **Solar energy (30.6%)**, followed by a strong cluster in **systems integration / smart grids / digital energy** (18.6%). Together, these two areas represent **nearly half of the sample**, which helps explain why operational digital needs (monitoring, data use, SCADA/IoT) are repeatedly emphasized later.
- **Wind (12.1%)** and **Hydrogen (9.7%)** are also well represented, providing meaningful input for both current and emerging skills needs (e.g., advanced O&M, safety, grid integration, and new technology readiness).
- A smaller share of participants come from **adjacent electrification sectors** (notably automotive mechatronics/e-mobility). These perspectives remain relevant as they reflect the broader "twin transition" skills convergence; however, they should be interpreted as **complementary evidence** rather than sector-exclusive technician demand.

## Q2. RES Representation



## Question 3

**"In which country do you primarily operate or work?"**

Q3 captures the **geographical spread** of respondents' primary operation/work. In an EU-level skills needs analysis, this information is used to **describe the sample context** and support transparency about participation patterns. In line with the agreed approach, Q3 is **not used for national comparisons** or country-by-country interpretation of results.

### Q3. Results (n=124)

Responses came mainly from:

1. **Portugal**: 41 (33.1%)
2. **Italy**: 39 (31.5%)
3. **Greece**: 14 (11.3%)
4. **France**: 11 (8.9%)
5. **Netherlands**: 5 (4.0%)
6. **Other EU countries (combined)**: 11 (8.9%)
   (Austria, Belgium, Finland, Germany, Spain, Bulgaria, Ireland)
7. **Other/unspecified**: 3 (2.4%)

| Q3. Country distribution | n | % (of n=124) |
|---|---|---|
| Portugal | 41 | 33.1% |
| Italy | 39 | 31.5% |
| Greece | 14 | 11.3% |
| France | 11 | 8.9% |
| Netherlands | 5 | 4% |
| Other EU countries (combined) *(Austria, Belgium, Finland, Germany, Spain, Bulgaria, Ireland)* | 11 | 8.9% |
| Other/unspecified | 3 | 2.4% |

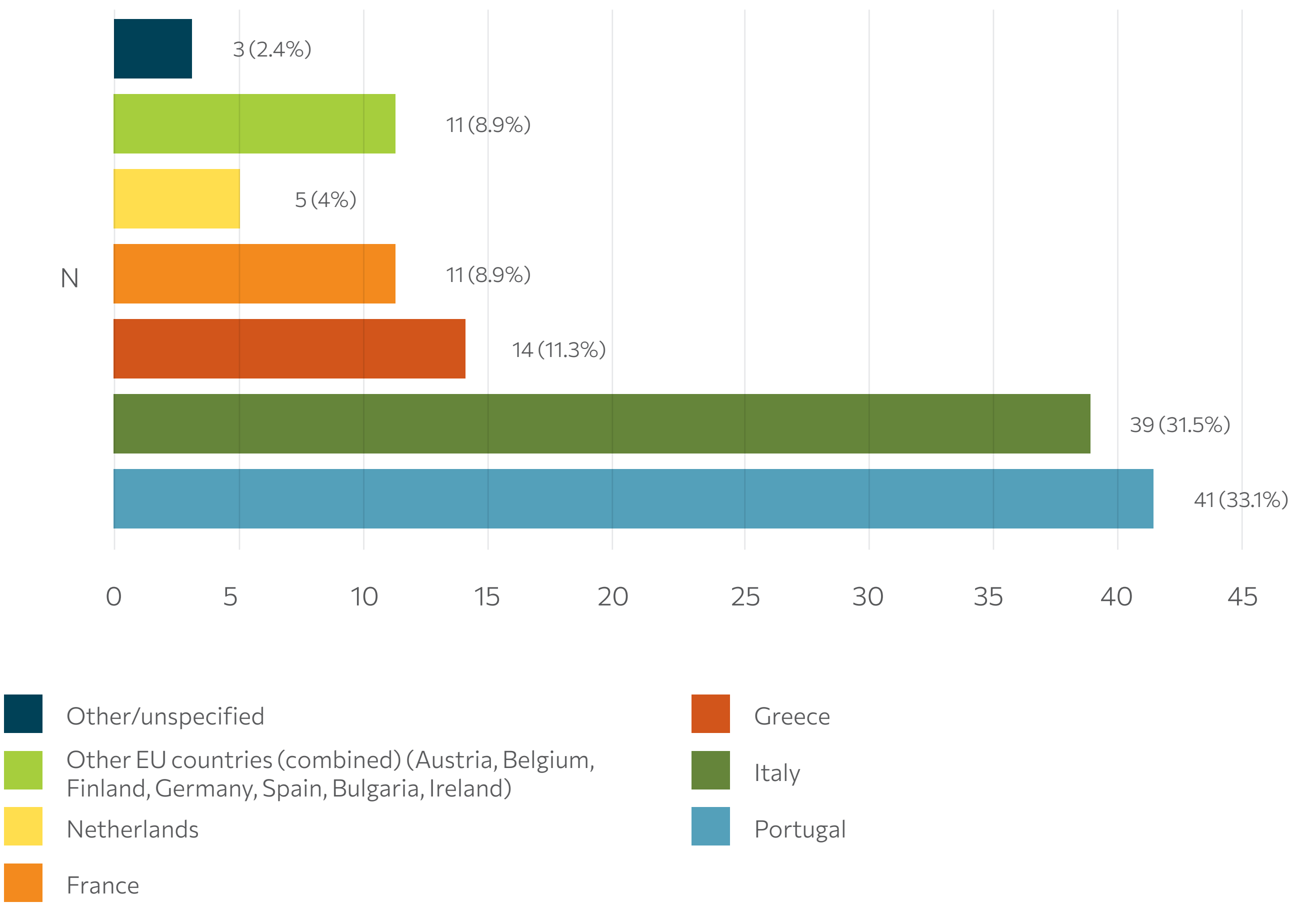
**Notes on harmonization:**

- "Other EU countries (combined)" groups low-frequency countries to keep the main report readable; the full breakdown can be placed in an annex if needed.
- "Other/unspecified" reflects responses labelled "Other" in the form.

### Q3. Results synopsis

The sample is concentrated in Portugal and Italy (64.6% combined), followed by Greece and France. This distribution likely reflects partner outreach and participation patterns and is therefore treated as contextual metadata rather than a basis for national comparisons. The subsequent analysis aggregates results at EU level, focusing on overall skills priorities and cross-cutting needs for Renewable Energy Technicians.

### Q3. Country distribution



## "Years of experience in the renewable energy sector"

Q4. 'Years of experience in the RES' captures the respondents seniority and exposure to sector practices. Experience levels influence how participants perceive skills needs: early-career respondents often highlight **foundational training needs**, while highly experienced respondents tend to emphasize **advanced operational**, **compliance**, **and system-integration gaps**. In an EU-level skills needs analysis, this variable is used to **contextualize** the findings (not to segment results unless needed later).

### Q4. Experience in RES (n=124)

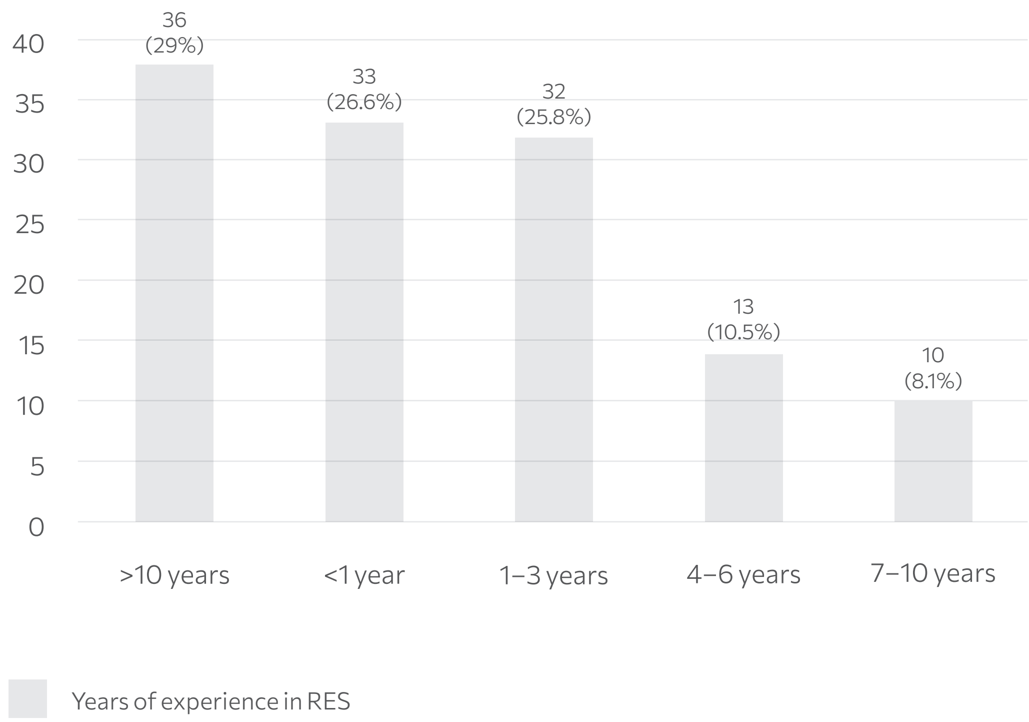
1. **>10 years:** 36 (29.0%)
2. **<1 year:** 33 (26.6%)
3. **1–3 years:** 32 (25.8%)
4. **4–6 years:** 13 (10.5%)
5. **7–10 years:** 10 (8.1%)

| Q4. Experience in RES | n | % (of n=124) |
|---|---|---|
| >10 years | 36 | 29% |
| <1 year | 33 | 26.6% |
| 1–3 years | 32 | 25.8% |
| 4–6 years | 13 | 10.5% |
| 7–10 years | 10 | 8.1% |

### Q4. Results synopsis

The respondent group includes both highly experienced professionals and a substantial share of new entrants. Nearly three in ten participants report **more than 10 years of experience (29.0%)**, providing strong insight into long-term operational realities and evolving competence requirements. At the same time, over half of respondents have **three years of experience or less (52.4%)**, indicating significant representation of early-career profiles and learners who are closer to current training pathways and onboarding needs.
This mix supports an EU-level skills needs analysis that captures both (a) **immediate upskilling priorities** for the current workforce and (b) **entry-level competence requirements** for new technicians entering the sector.

**Q4. Experience in RES**




### Question 5

**"Type of organization you currently work for"** (Select one from the following options)

**Q5. Type of organization (Participant Profile) question** identifies the **institutional setting** in which respondents operate (industry, training providers, public sector, NGOs, etc.). In a skills needs analysis, this helps interpret whether findings primarily reflect **workplace demand signals** (e.g., SMEs/large enterprises/self-employed) and/or **training system perspectives** (e.g., educational/training institutions), which is important when discussing feasibility of delivery formats such as work-based learning, blended training, and microcredentials.

**Q5. Organization type (n=124)**

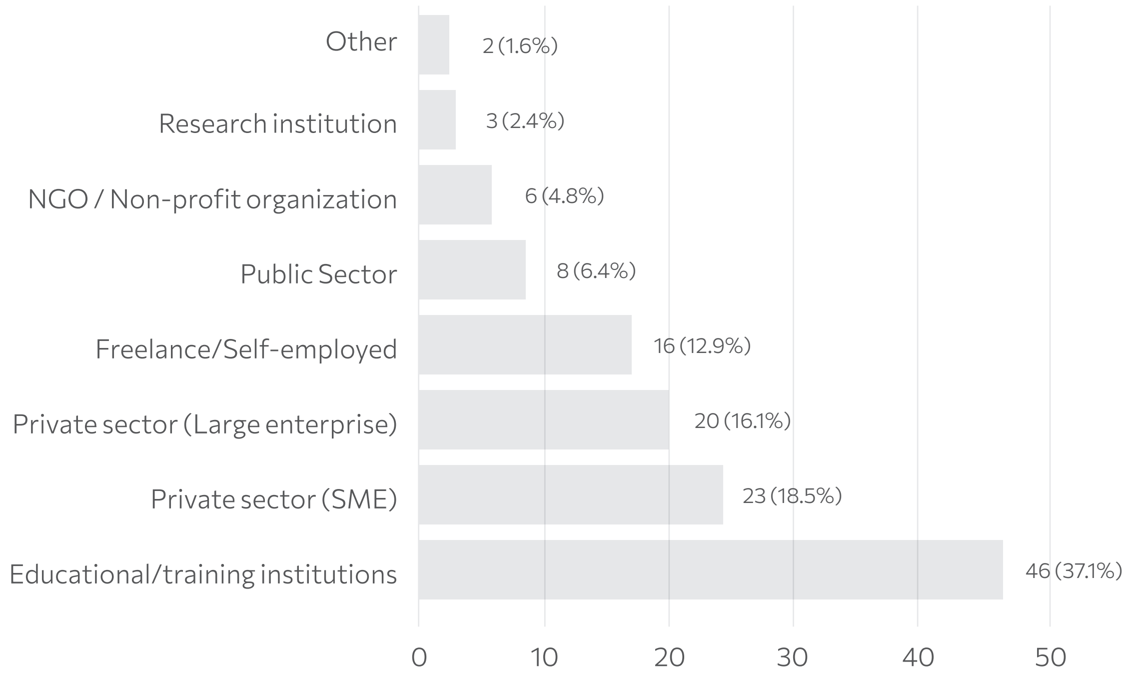
1. **Educational/training institutions**: 46 (37.1%)
2. **Private sector (SME)**: 23 (18.5%)
3. **Private sector (Large enterprise)**: 20 (16.1%)
4. **Freelance/Self-employed**: 16 (12.9%)
5. **Public sector**: 8 (6.4%)
6. **wNGO / Non-profit organization**: 6 (4.8%)
7. **Research institution**: 3 (2.4%)
8. **Other**: 2 (1.6%)

| Q5. Type of Organization | n | % (of n=124) |
|---|---|---|
| Educational/training institutions | 46 | 37.1% |
| Private sector (SME) | 23 | 18.5% |
| Private sector (Large enterprise) | 20 | 16.1% |
| Freelance/Self-employed | 16 | 12.9% |
| Public Sector | 8 | 6.4% |
| NGO / Non-profit organization | 6 | 4.8% |
| Research institution | 3 | 2.4% |
| Other | 2 | 1.6% |

## Q5. Results synopsis

The sample includes a strong representation from **educational and training institutions (37.1%)**, alongside substantial participation from the private sector (SMEs and large enterprises combined: 34.7%) and self-employed/freelance professionals (12.9%). This distribution supports a balanced EU-level perspective that captures both **training provision realities** (curriculum capacity, delivery constraints, trainer readiness) and **labour-market demand** (skills requirements in operational settings). The presence of public sector, NGO/non-profit and research organizations, although smaller, adds additional viewpoints relevant to policy, sustainability priorities, and innovation uptake.

## Q5. Type of Organization



## Digital skills (Q6)

### Question 6

**"Which of the following Digital Skills are the most in need for a Renewable Energy Technician"**

Q6 captures which **digital competences** respondents consider most needed for Renewable Energy Technicians, using a 5-point "in need" scale. In a sector increasingly shaped by digital monitoring, data-driven maintenance, automation, and connected systems, these ratings provide an EU-level indication of where **upskilling priorities** should focus (e.g., for modular training and microcredentials).

### Q6. Results (n=124)

Respondents rated eight digital skill areas. Ranked by **mean "in need" score** (1–5) and **Top-2-box** share ("Much/Very much in need"):

1. **Adaptability to learn new digital tools**-mean 3.93, Top-2 66.7%
2. **Basic digital literacy**-mean 3.80, Top-2 62.6%
3. **Data analysis tools for performance monitoring**-mean 3.72, Top-2 64.2%
4. **Digital monitoring/control systems (SCADA)**-mean 3.64, Top-2 57.7%
5. **IoT & sensor technologies**-mean 3.57, Top-2 51.2%
6. **Cybersecurity awareness**-mean 3.45, Top-2 48.8%
7. **Design/simulation software (e.g., CAD)**-mean 3.21, Top-2 44.7%
8. **Basic programming/coding**-mean 3.04, Top-2 33.3%

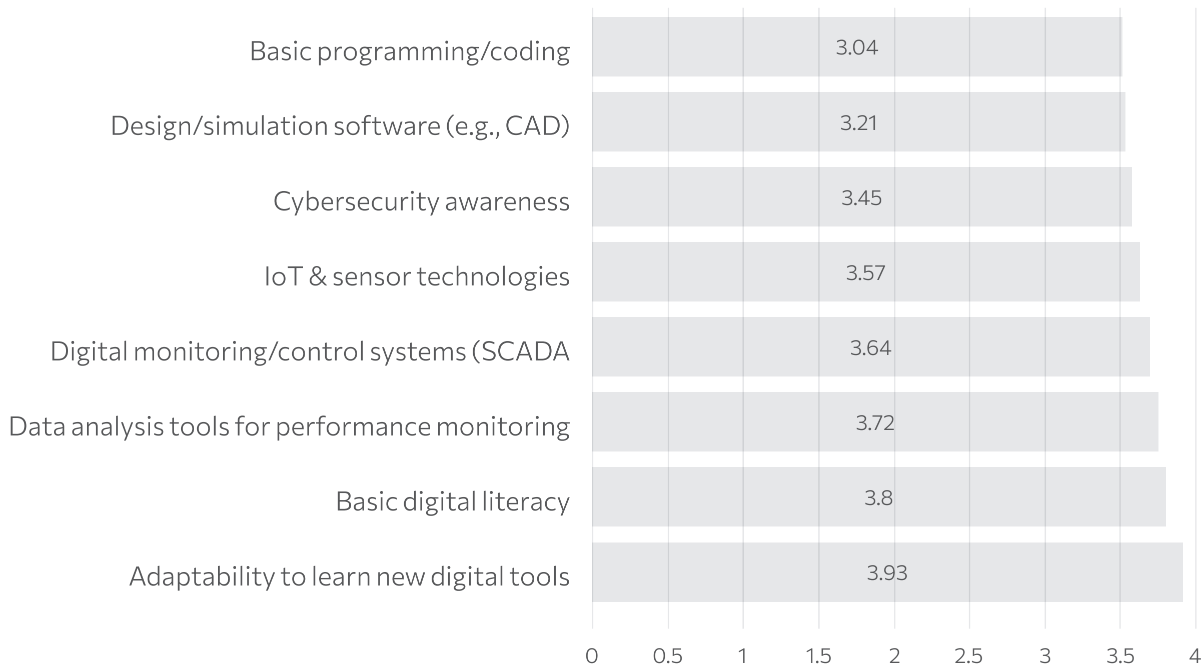
| Q6. Digital Skills most in need | Mean | Top-2% (Much/Very much in need) |
|---|---|---|
| Adaptability to learn new digital tools | 3.93 | 66.7% |
| Basic digital literacy | 3.8 | 62.6% |
| Data analysis tools for performance monitoring | 3.72 | 64.2% |
| Digital monitoring/control systems (SCADA) | 3.64 | 57.7% |
| IoT & sensor technologies | 3.57 | 51.2% |
| Cybersecurity awareness | 3.45 | 48.8% |
| Design/simulation software (e.g., CAD) | 3.21 | 44.7% |
| Basic programming/coding | 3.04 | 33.3% |

## Q6. Results synopsis

- The strongest signal is a clear **“learning agility” requirement**: stakeholders expect technicians to continuously adopt new digital tools (highest mean score)
- Beyond foundational digital literacy, the results show a strong operational emphasis on **data-enabled maintenance and performance**, with high priority placed on **data analysis, SCADA/monitoring systems**, and **IoT/sensors**-all essential for efficient operation and troubleshooting in modern RES installations.
- **Cybersecurity awareness** is a mid-level priority but still significant, with nearly half of respondents indicating it is “much/very much” needed.
- **Basic programming/coding** ranks lowest, suggesting that most stakeholders do not expect technicians to code extensively, but rather to **use and interact confidently** with digital systems that support monitoring, diagnostics, and automation.

These priorities align with DigComp areas related to **Information & data literacy**, **Problem solving in digital contexts**, and **Safety** (cybersecurity), reinforcing the need for training pathways that combine practical tool use with safe and responsible digital practice.

## Q6. Digital Skills most in need



## Green skills (Q7-Q8)

### Question 7

**"Which of the following Green Skills do you consider the most in need for a RES Technician to perform effectively?"**

Q7. Green skills "in need" for Renewable Energy Technicians (Skills Importance) assesses which **green competences** stakeholders consider most needed for Renewable Energy Technicians, reflecting the practical requirements of the green transition (e.g., energy efficiency, compliance, sustainable work practices, and systems thinking). These findings support prioritization of green learning outcomes aligned with **GreenComp** and help shape the later gap analysis and training recommendations.

### Q7. Results (n=124)

Eight green skill areas were rated. Ranked by mean score and Top-2-box (Agree/Strongly agree):

1. **Optimize systems for energy efficiency** - mean 4.01, Top-2 72.4%
2. **Follow environmental regulations & safety standards** - mean 4.00, Top-2 71.5%
3. **Evaluate/reduce environmental impacts of work practices** - mean 3.82, Top-2 63.4%
4. **Minimize material waste / resource efficiency** - mean 3.75, Top-2 60.2%
5. **"Big picture" systems thinking (environmental, social, economic interconnections)** mean 3.72, Top-2 62.6%
6. **Prioritize sustainability in decisions (reduce overall carbon footprint of projects)** mean 3.72, Top-2 56.9%
7. **Advocate for greener solutions on the job (suggest improvements to efficiency/reduce harm)** mean 3.65, Top-2 57.7%
8. **Support fairness/equity in renewable initiatives** mean 3.65, Top-2 57.7%

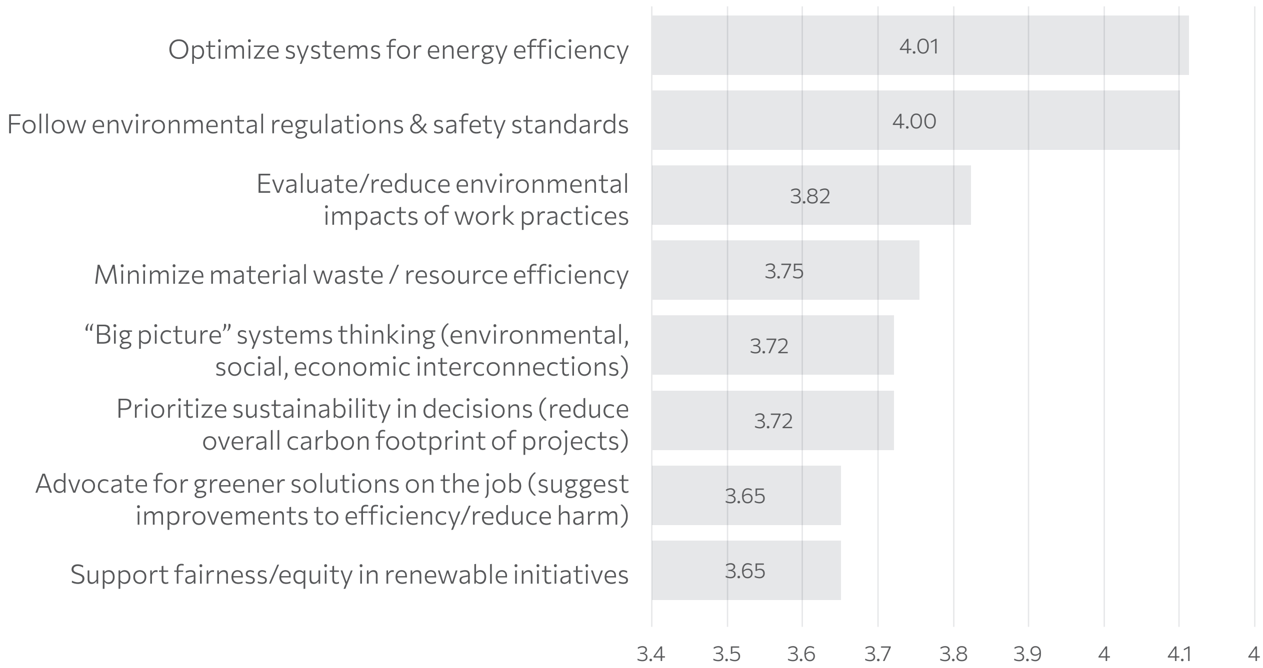
| Q7. Green skills most in need (n=124) | Mean | Top-2 (% "Much/Very much in need") |
|---|---|---|
| Optimize systems for energy efficiency | 4.01 | 72.4% |
| Follow environmental regulations & safety standards | 4.00 | 71.5% |
| Evaluate/reduce environmental impacts of work practices | 3.82 | 63.4% |
| Minimize material waste / resource efficiency | 3.75 | 60.2% |
| "Big picture" systems thinking (environmental, social, economic interconnections) | 3.72 | 62.6% |
| Prioritize sustainability in decisions (reduce overall carbon footprint of projects) | 3.72 | 56.9% |
| Advocate for greener solutions on the job (suggest improvements to efficiency/reduce harm) | 3.65 | 57.7% |
| Support fairness/equity in renewable initiatives | 3.65 | 57.7% |

### Q7. Results synopsis

- Green skills are anchored in practical compliance and performance: efficiency optimization and regulatory/safety compliance are the clearest priorities, reflecting the operational nature of technician roles and the importance of safe, compliant work practices.
- A second tier focuses on impact-aware daily practice: reducing environmental footprint and resource/waste efficiency.
- The social dimension (fairness/equity) is still relevant but comparatively lower than "core operational green competence."

**Framework Alignment:** These priorities align with the GreenComp framework related to acting for sustainability (efficiency and resource use), **embedding sustainability through compliance and safe handling**, and **embracing complexity** (systems thinking), supporting the integration of green competences into technician training pathways.

### Q7. Green skills most in need



## Question 8

**"Are there specific digital and green skill gaps or needs currently observed in your sector? And in which jobs/professions?" (Cross-cutting stakeholder observations on digital–green skill gaps, open-ended question)**

### Q8. Notes and base for synthesis

- Responses were multilingual, with non-English inputs reflected here in English.
- From the submitted comments, **~93 were substantive** (excluding "No / N/A / don't know / punctuation-only" style replies).
- *Themes below are non-exclusive* (one response can mention multiple improvements), so totals will exceed 100%.

Q8 complements the closed-ended importance ratings (Q6–Q7) by capturing **practical**, **field-based examples** of where gaps are observed and **which job profiles are affected**. Responses included a mix of detailed comments and short answers ("No," "Don't know," "N/A"). The synthesis below presents an **EU-level thematic review** (not country-by-country reporting), translating non-English responses into English and consolidating recurring topics.

### Overall pattern of responses

Three response patterns emerged:

1. **Digital skills gaps were clearly observed**: A substantial set described deficits in operational digital skills, especially data use, monitoring/control systems, and cybersecurity awareness.
2. **Green gaps clearly observed**: Many highlighted gaps in systems integration (moving from component installation to optimized system performance), alongside circular economy practices, regulatory compliance, and impact assessment.
3. **No gaps perceived/uncertainty**: Several respondents answered that they did not observe gaps or were unsure, with some noting that skills can be sourced externally (e.g., consultants) or that technicians' motivation for further training can be low.

#### A. Observed Digital Skills gaps (what is missing in practice)

Across the responses, "digital gaps" were most frequently described as applied, operational digital competence rather than advanced software development. Key themes included:

- **AI, automation, robotics, and predictive maintenance (emerging operational digital competence):** A substantial set of comments referenced the growing importance of automation and AI-enabled approaches (e.g., predictive maintenance, anomaly detection, and robotics/drones for inspection), noting that current practice and training do not yet equip technicians to use these tools effectively.
- **Data literacy and performance monitoring:** Respondents noted that many technicians can collect data but struggle to interpret it and translate it into performance improvements. This reinforces the high importance ratings in Q6 for data analysis tools and monitoring.

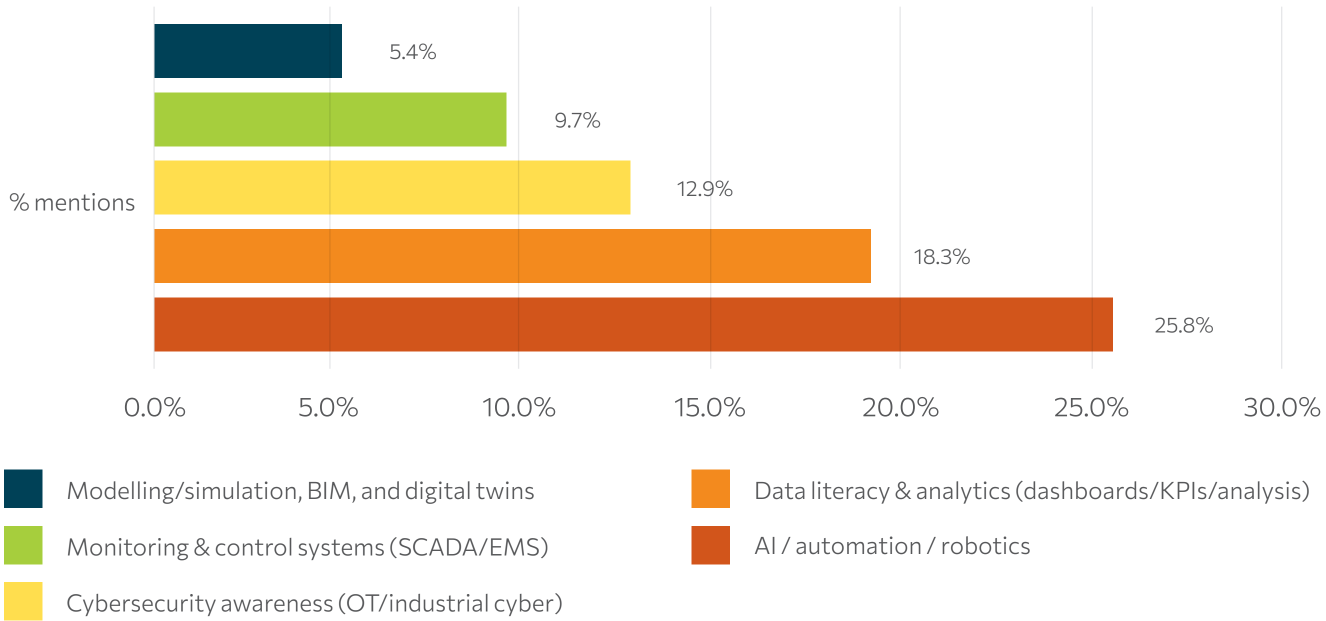
- **Cybersecurity awareness:** Industrial/energy cybersecurity awareness was repeatedly mentioned, particularly for field technicians and asset/operations roles.
- **Digital monitoring and control systems (SCADA/EMS):** Several respondents pointed to limited proficiency with monitoring/control systems used in modern RES installations.
- **Modelling/simulation, BIM, and digital twins (where relevant):** Some respondents highlighted gaps in reading BIM models on site and using simulation/digital twin methods in design, planning, and optimization workflows.

| Q8. Observed Digital Skills Gaps | Mentions (n) | % (of n=93 substative) |
|---|---|---|
| AI / automation / robotics | 24 | 25.8% |
| Data literacy & analytics (dashboards/KPIs/analysis) | 17 | 18.3% |
| Cybersecurity awareness (OT/industrial cyber) | 12 | 12.9% |
| Monitoring & control systems (SCADA/EMS) | 9 | 9.7% |
| Modelling/simulation, BIM, and digital twins | 5 | 5.4% |

**Some illustrative anonymized examples:**

- "Technicians generate monitoring data, but few know how to use it to improve efficiency."
- "Gaps: SCADA/IoT, industrial cybersecurity, and predictive maintenance tools."
- "Basic digital literacy is missing, like reading BIM models on site."
- "Installers know the technical setup, but struggle with the digital part: app configuration, Wi-Fi issues, and smart control settings."

## Q8. Observed Digital Skills Gaps



## B. Observed Green skills gaps (what is missing in practice)

Respondents often framed “green gaps” as how sustainability is implemented in daily technical work, not only as general awareness. Key themes included:

- **System integration for real energy efficiency (NZEB/ZEB logic):** A recurring theme was that technicians may install individual components (PV panels, heat pumps, etc.) but lack skills to integrate them into **a single optimized energy system**, especially in advanced energy-efficient building contexts.
- **Circular economy practices in fieldwork:** Waste reduction, dismantling/recycling, and resource efficiency were raised as gaps in daily installation and maintenance practices.
- **Regulatory compliance and documentation:** Several responses highlighted the need to keep up with evolving permits, implementing decrees, and compliance documentation-particularly affecting engineering, project development, and compliance roles.
- **LCA/ESG/carbon accounting and environmental data management:** Some respondents noted that organizations increasingly need competences in LCA/LCC, ESG reporting, and carbon footprinting, but training and workforce readiness lag behind.
- **Environmental impact assessment and biodiversity considerations**: A smaller but high-value cluster pointed to deficits in EIA, biodiversity impacts, and consultation processes, especially for planning and site-development roles.

| Q8. Observed Green Skills Gaps | Mentions (n) | % (of n=93) |
|---|---|---|
| LCA/ESG/carbon accounting & sustainability reporting | 18 | 19.4% |
| Circular economy / waste / recycling / dismantling | 13 | 14.0% |
| System integration for real efficiency | 11 | 11.8% |
| (NZEB/ZEB logic) | | |
| Regulatory compliance & documentation | 11 | 11.8% |
| Environmental impact assessment and biodiversity considerations | 5 | 5.4% |

**Some illustrative anonymized examples:**

- “Installers can install components but not integrate PV and heat pumps into an optimized NZEB network.”
- “We need more skills in LCA and circular economy; dismantling and recycling are weak.”
- “Constant updating on regulatory procedures is essential; documentation must adapt to changing authorizations.”
- “Gaps in impact studies and biodiversity considerations (birds, bats, marine environment).”

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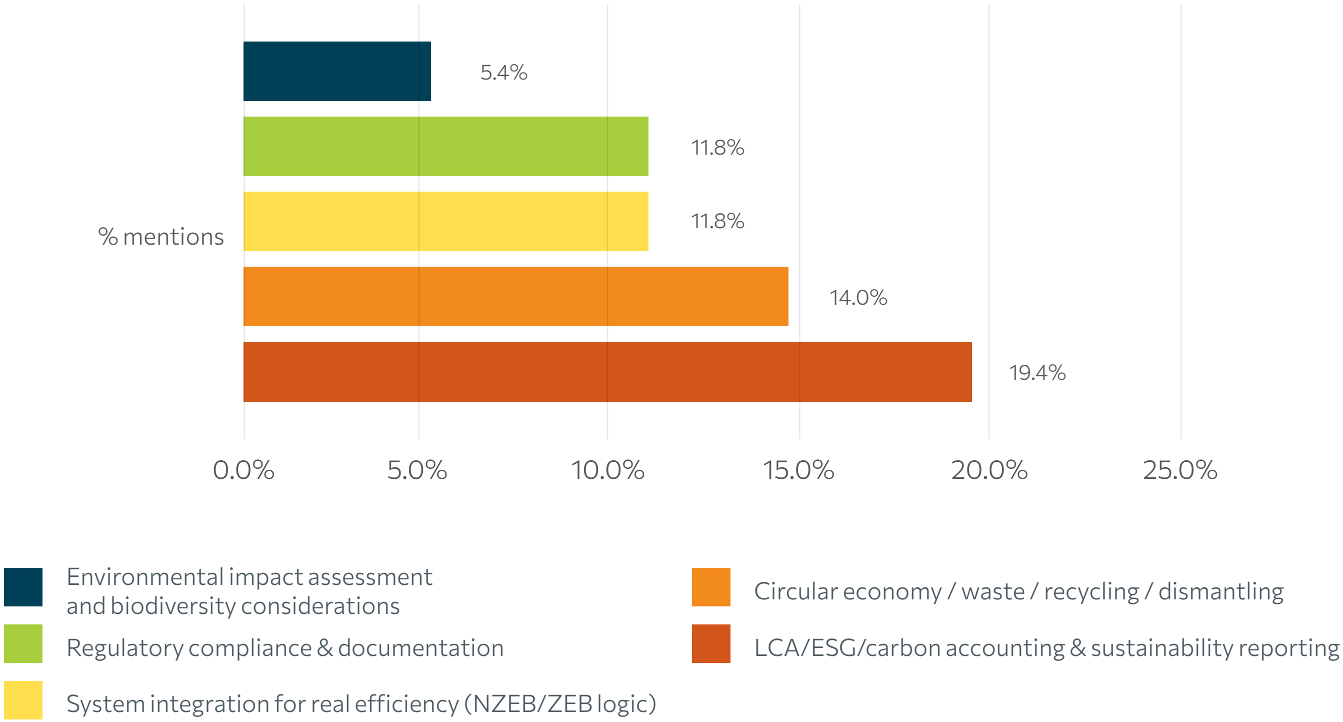
## Q8. Observed Green Skills Gaps




### C. Cross-cutting insights: Where Digital and Green skills converge

A particularly important contribution of Q8 is how it shows convergence between digital and green skills:

- **Multidisciplinarity and integration**: Several respondents explicitly mentioned a lack of "integration skills" across functions (HSE, process, IT), aligning with the need for hybrid profiles combining technical knowledge with digital and sustainability competence.
- **Training pipeline lag**: Some responses emphasized that education and training systems "change slower than the workfield," and that trainers may lack resources (e.g., digital simulation environments) or preparation to teach emerging digital-green combinations.
- **Workforce availability and maintenance ecosystem**: Shortages of technicians (electricians, installers) and weak maintenance/support ecosystems were raised, reinforcing the need for scalable upskilling pathways.

**Illustrative anonymized examples (translated):**

- "Lack of multidisciplinarity and integration skills is often mentioned."
- "Education criteria change slower than the workfield."
- "There's a shortage of technicians (electricians/installers) and maintenance support is lacking."

### D. Jobs/professions most frequently referenced

Across the responses, the roles most cited as affected by digital–green gaps included:

- **Field technicians / maintenance technicians / installers** (PV, wind, heat pumps, integrated systems)
- **Industrial technicians and electricians**
- **Engineers** (electrical/mechanical/chemical; design and R&D; hydrogen facilities)
- **Asset/operations managers and project managers**
- **Compliance/QA-QC/ESG-related functions**
- **Trainers/teachers and training organizations** (curriculum/trainer readiness)

| Q8. Job/Professions Mentioned | Mentions (n) | % (of n=93 substative) |
|---|---|---|
| Field technicians/installers/O&M | 18 | 19.4% |
| Engineers (design/R&D/power/hydrogen) | 12 | 12.9% |
| IT/data-oriented roles | 10 | 10.8% |
| Managers (asset/operations/project/planning) | 7 | 7.5% |
| Compliance/QA-QC/ESG functions | 6 | 6.5% |
| Industrial technicians/electricians | 6 | 6.5% |

### Q8. Results synopsis/key takeaways

Overall, Q8 provides qualitative confirmation of the survey's main quantitative signals:

1. Digital needs are framed primarily as operational capability: AI/automation-enabled maintenance, using data, SCADA/monitoring systems, IoT sensors, and applying cybersecurity awareness in field contexts-rather than heavy coding.
2. Green needs are anchored in performance and compliance (efficiency, regulations/safety) but also extend to higher-level sustainability practice such as circular economy implementation, LCA/ESG reporting readiness, and system integration for NZEB/ZEB outcomes.
3. Importantly, Q8 highlights that these requirements increasingly demand hybrid profiles and that training provision must evolve faster to reflect converging digital–green practices.

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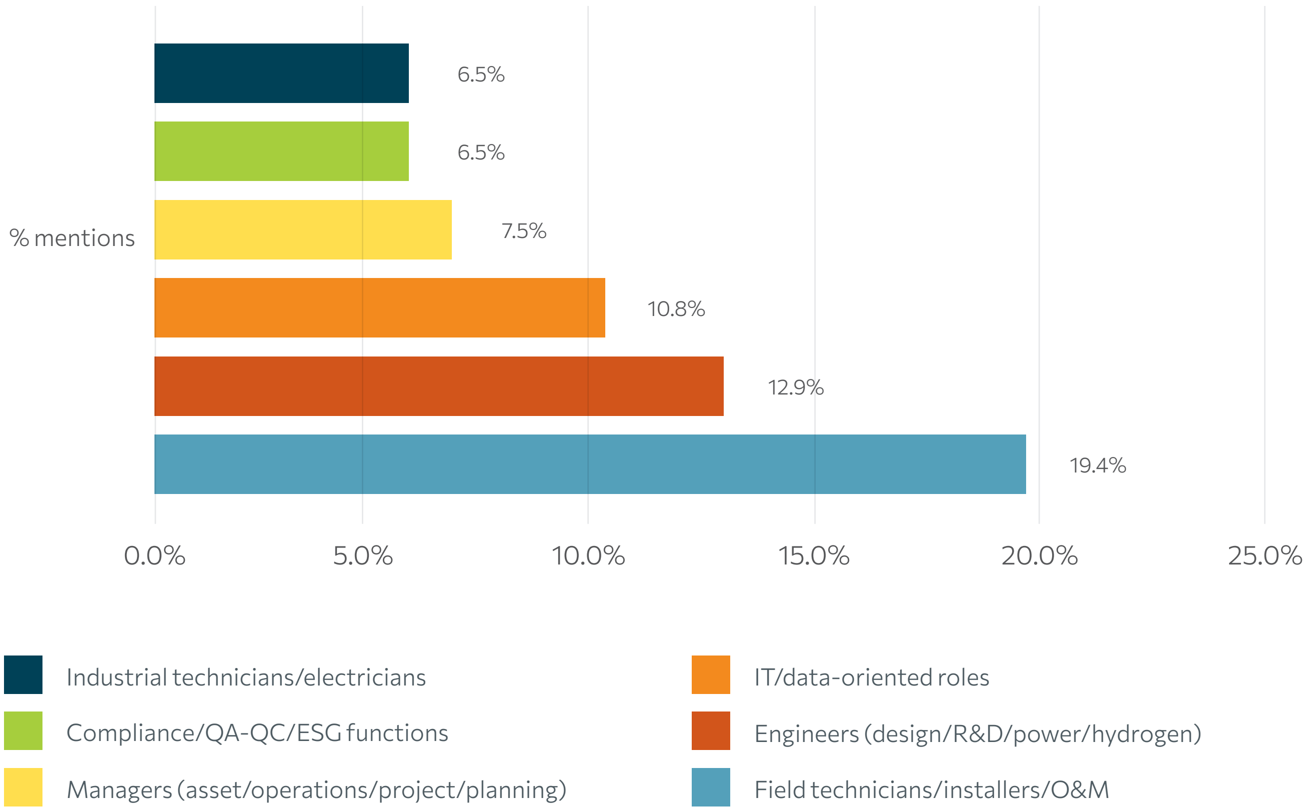
### Q8. Job/Professions Mentioned




## Soft skills (Q9)

### Question 9

**"Which of the following Soft skills are the most in need for a renewable energy technician?" (Q9, N=124)**

Q9 captures the **soft skills profile** considered most important for Renewable Energy Technicians, recognizing that technician effectiveness depends not only on technical/digital competence but also on **safe decision-making**, **teamwork**, **adaptability**, **and problem-solving** in dynamic work environments.
Unlike Q6–Q7, Q9 is a *forced-choice* design: respondents selected **the most important skill** within each of four soft-skill areas (9a–9d). Results therefore indicate **relative priorities within each area**, not overall "importance scores."

### Q9. Results (N=124)

Respondents selected one priority soft skill in each area:

**9a. Personal area**

- **Flexibility/adaptability**: 79 (63.7%)
- Self-regulation: 27 (21.8%)
- Well-being/resilience: 18 (14.5%)

**9b. Social area**

- **Collaboration/teamwork**: 59 (47.6%)
- Communication: 47 (37.9%)
- Empathy/emotional intelligence: 18 (14.5%)

**9c. Learning to learn**

- **Critical thinking**: 50 (40.3%)
- Growth mindset: 44 (35.5%)
- Managing learning: 30 (24.2%)

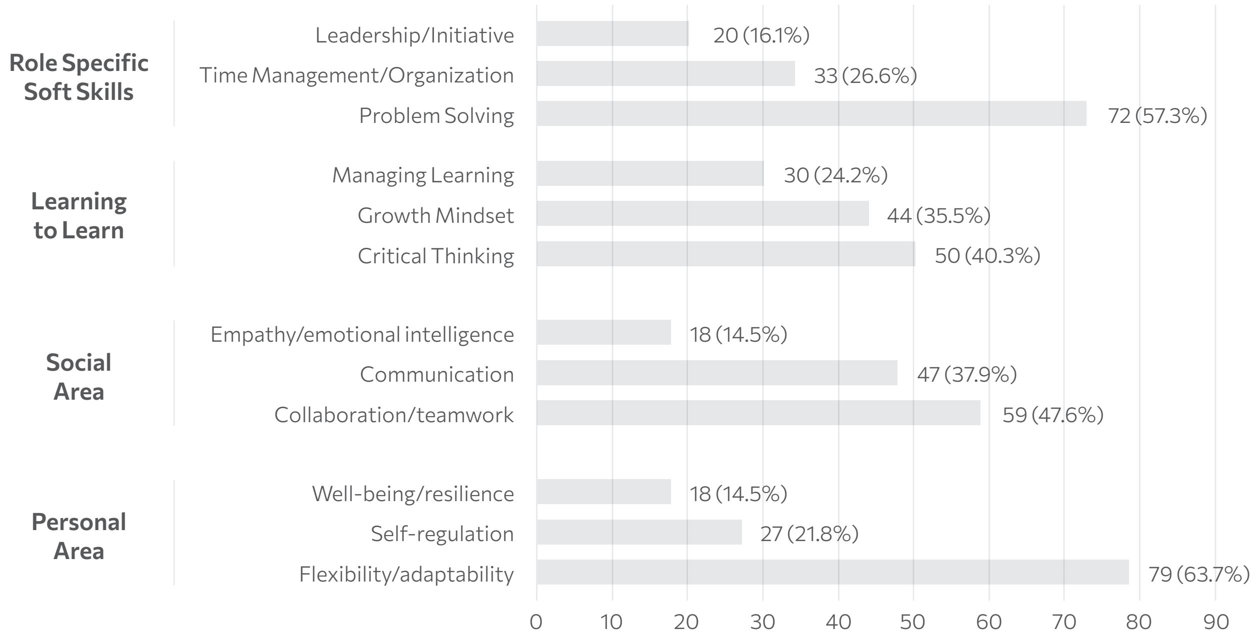
**9d. Role-specific soft skills**

- **Problem solving**: 71 (57.3%)
- Time management/organization: 33 (26.6%)
- Leadership/initiative: 20 (16.1%)

### Q9. Results synopsis

- Across the four soft-skill areas, respondents converge around a profile of an "adaptive problem solver."
- In the personal domain, flexibility/adaptability dominates, reflecting the reality that technicians must respond to changing technologies, procedures, and on-site conditions.
- Socially, collaboration/teamwork and communication both score strongly, consistent with multi-stakeholder work settings (coordination with engineers, supervisors, clients, and safety roles)
- In learning-to-learn, critical thinking is the top learning-to-learn competence, being particularly important for safety, diagnosis, and context-specific decisions.

### Q9. Soft Skills most in need



## Technical skills gaps and emerging skills (Q10–Q11, open-ended)

### Question 10

**"What specific technical skills do you believe are currently lacking or insufficient in your Renewable Energy System (RES) field? And in which jobs/professions?"**

### Q10. Notes and base for synthesis (open-ended)

- Responses were multilingual; non-English inputs are reflected here in English.
- From the submitted comments, n=97 were coded as substantive (excluding "No / N/A / don't know / punctuation-only" style replies).
- Themes below are non-exclusive (one response may mention multiple gaps), so totals exceed 100%.

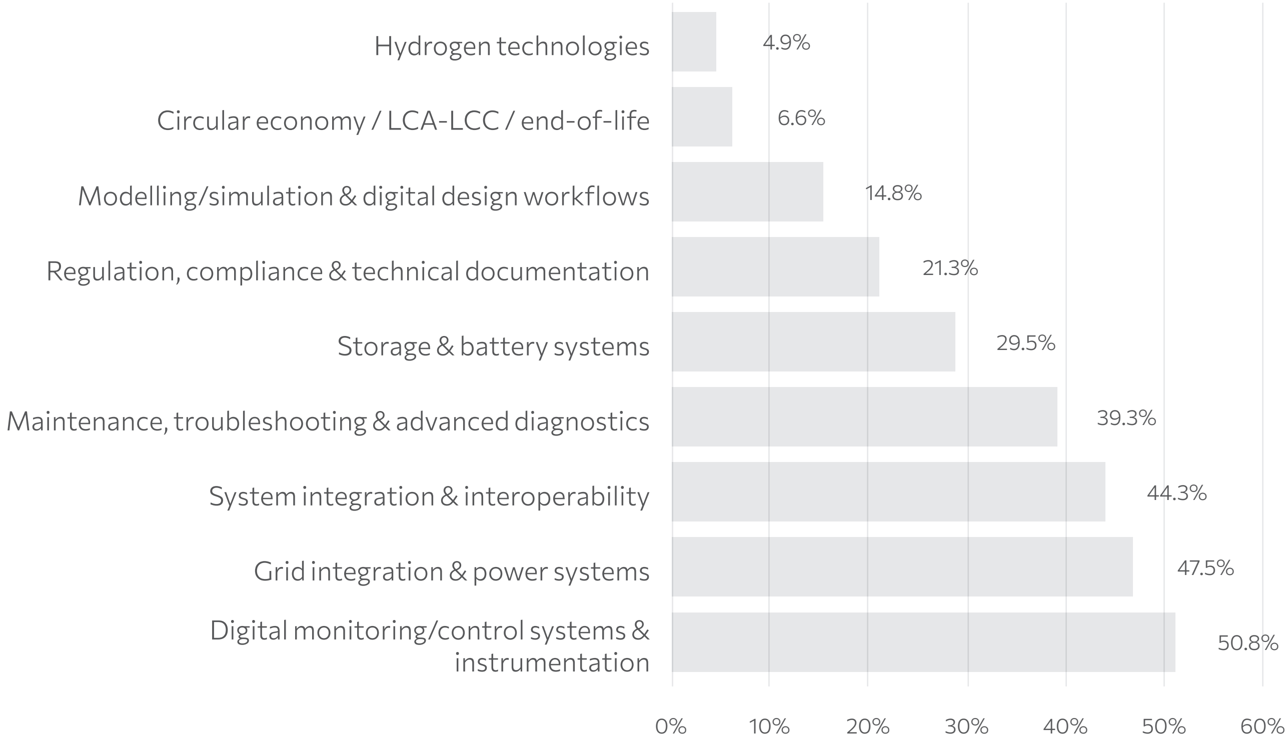
Q10 captures current technical skills gaps affecting Renewable Energy Technicians and adjacent RES roles. Responses are pointing less to abstract theory gaps and more to applied competence in integration, commissioning, diagnostics, safe work, and documentation, particularly as operations become more digitalized and interconnected.

Indicative recurrence:

- **High recurrence**: monitoring/control systems & instrumentation (SCADA/RTU/EMS); grid integration & HV/MV safety; system integration/interoperability; troubleshooting & diagnostics
- **Medium recurrence**: storage systems (BESS/BMS); regulation/compliance/documentation; modelling/simulation
- **Lower but important**: circular economy/LCA-LCC/end-of-life; hydrogen operations & safety

| Q10. Observed Technical Skills Gaps | Mentions (n) | % (of n=97) |
|---|---|---|
| Digital monitoring/control systems & instrumentation | 49 | 50.8% |
| Grid integration & power systems | 46 | 47.5% |
| System integration & interoperability | 43 | 44.3% |
| Maintenance, troubleshooting & advanced diagnostics | 38 | 39.3% |
| Storage & battery systems | 29 | 29.5% |
| Regulation, compliance & technical documentation | 21 | 21.3% |
| Modelling/simulation & digital design workflows | 14 | 14.8% |
| Circular economy / LCA-LCC / end-of-life | 6 | 6.6% |
| Hydrogen technologies | 4 | 4.9% |

## Q10. Observed Technical Skills Gaps




### Q10. Synopsis (main themes emerging from the answers):

A. **Digital monitoring/control systems & instrumentation (SCADA/RTU/PLC/EMS, sensors): 49** (~50.8%)

- A repeated theme is limited proficiency with **SCADA/RTU**, digital supervision platforms, commissioning of monitoring, and **the practical use of sensors** (installation, configuration, observability).
- **Roles mentioned**: SCADA/controls technicians, O&M teams, asset operations roles, and commissioning roles.

Illustrative examples*:*

- "Technicians are not fully trained to program RTUs and operate SCADA monitoring."
- "Knowledge of sensors and their complexity is often superficial."

B. **Grid integration & power systems (protections, inverters, HV/MV safety): 46** (~47.5%)

- Several answers highlight gaps in grid connection know-how, protections, power electronics, and HV/MV fundamentals-often paired with strong safety concerns for newer technicians.
- **Roles mentioned:** electricians, grid-connection engineers, power systems engineers, PV utility-scale construction/site managers, and field technicians.

Illustrative examples*:*

- “Qualified electricians for power-to-grid works are hard to find.”
- “Work on medium/high voltage cannot be done safely with only a few hours of training.”

C. **System integration & interoperability (hybrid RES + buildings + grids): 43** (~44.3%)

- A dominant theme is that professionals can install individual components (PV, heat pumps, storage, EV charging, and hydrogen subsystems) but lack the competence to integrate them into an optimized whole (smart homes, microgrids, and NZEB contexts).
- This includes practical integration with **BMS/HEMS/EMS**, and understanding interfaces/dependencies across disciplines (electrical–mechanical–automation–IT).
- **Roles mentioned**: installers, commissioning engineers, energy system engineers, O&M technicians, system integrators, and facility/building operations roles.

Illustrative anonymized examples (translated):

- “In a smart home or microgrid, many technologies must interact properly-integration skills are missing.”
- “Installers can mount components but lack troubleshooting and optimization skills in complex hybrid systems.”

D. **Maintenance, troubleshooting & advanced diagnostics (O&M reality): 38** (~39.3%)

- Many respondents point to a shortfall in **fault diagnosis**, **advanced troubleshooting**, and **preventive/predictive maintenance**, particularly when systems are digitally controlled and remotely monitored.
- **Roles mentioned**: O&M technicians (onshore/offshore), field service engineers, control room operators, and maintenance technicians.

Illustrative examples*:*

- “Good technicians can install, but fewer can maintain and troubleshoot-this is a problem in renewables.”
- “Technicians struggle with complex faults and interpreting system error codes.”

E. **Storage & battery systems (BESS/BMS, safe handling, and optimization): 29** (~29.5%)

- Respondents point to skills shortages in **battery integration, BMS concepts**, storage sizing/operation, and using storage as an asset (not just “excess solar dumping”).
- **Roles mentioned**: PV installers, electricians, storage specialists, O&M teams, system designers.

Illustrative examples:

- "Many storage installations aren't optimized; storage should be used strategically, not only to store excess PV."

F. **Regulation, compliance & technical documentation: 21** (~21.3%)

- A smaller but important cluster highlights gaps in **keeping up with evolving regulation**, preparing/revising technical documentation, and compliance reporting-especially in project development and permitting-heavy environments.

G. **Modelling/simulation and digital design workflows: 14** (~14.8%)

- Some answers call for better use of **simulation tools** (e.g., MATLAB/Simulink, PVsyst), and in certain contexts **BIM/digital twin** thinking-mainly for design/R&D and planning rather than entry-level technicians.

H. **Circular economy / LCA-LCC / end-of-life and recycling: 6** (~6.6%)

- Several respondents mention weak competence in **life-cycle thinking**, dismantling/recycling, and circular economy logic-especially relevant as PV/battery/wind assets age.

I. **Hydrogen technologies (operations, safety, multifunctional technician profiles): 4** (~4.9%)

- Hydrogen-related responses emphasize the need for **multifunctional technicians** (electrical + instrumentation + mechanical + safe procedures + reporting/logbooks), especially in unmanned or high-safety contexts.

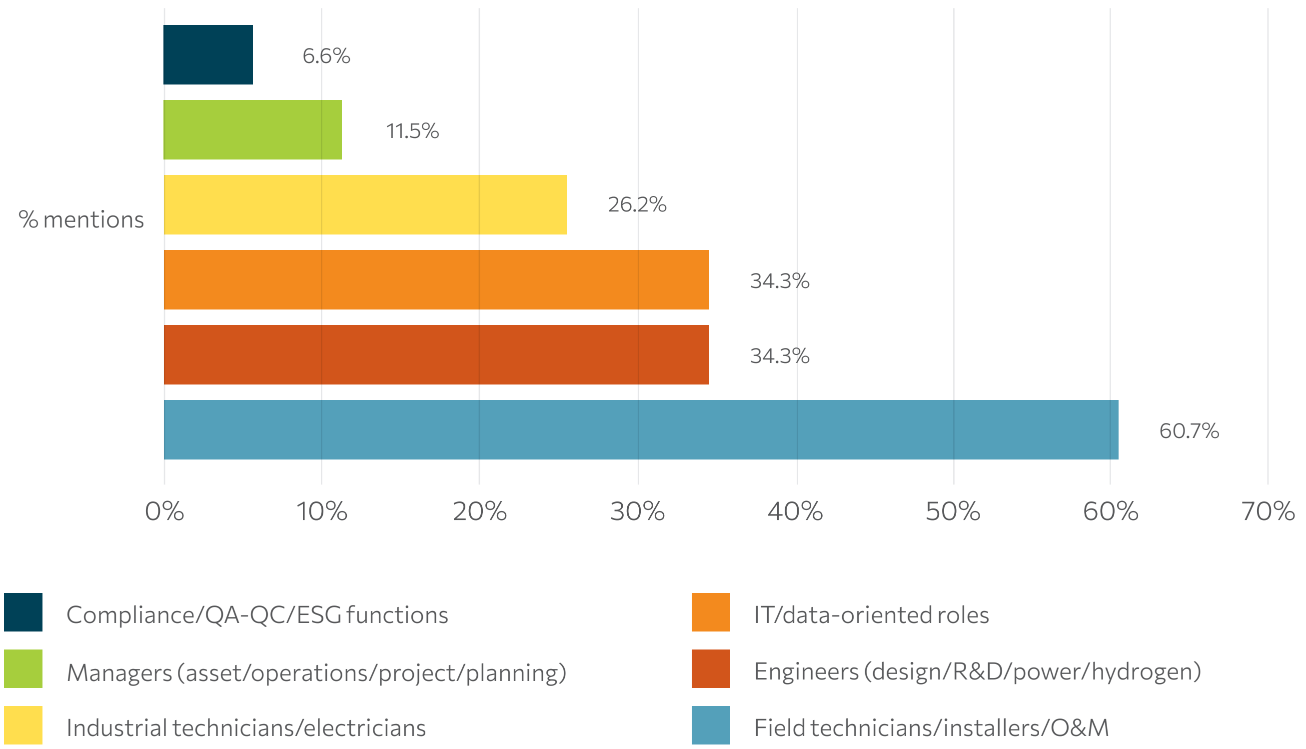
**Q10. Jobs/professions most frequently referenced**

Across the responses, the roles most cited as affected by technical skills gaps included:

- **Field technicians / maintenance technicians / installers** (PV, wind, heat pumps, integrated systems)
- **Engineers** (electrical/mechanical/chemical; design and R&D; hydrogen facilities)
- **IT/data-oriented roles**
- **Industrial technicians and electricians**
- **Asset/operations managers and project managers**
- **Compliance/QA-QC/ESG-related functions**

| Q10. Job/Professions Mentioned | Mentions (n) | % (of n=97) |
|---|---|---|
| Field technicians/installers/O&M | 59 | 60.7% |
| Engineers (design/R&D/power/hydrogen) | 33 | 34.4% |
| IT/data-oriented roles | 33 | 34.4% |
| Industrial technicians/electricians | 25 | 26.2% |
| Managers (asset/operations/project/planni ng) | 11 | 11.5% |
| Compliance/QA-QC/ESG functions | 6 | 6.6% |

## Q10. Job/Professions Mentioned




**Q10. Key takeaways from results:**

- The strongest current technical gaps are **operational digital monitoring/control competence** (SCADA/RTU/EMS, sensors, observability/data use) and **grid-facing competence** (grid integration, protections, inverters, HV/MV fundamentals, and safety).
- A closely related gap is **system integration/interoperability**: technicians are increasingly expected to integrate and optimize connected assets (PV + storage + smart grids/ buildings), not only install components.
- Many needs are **workplace-critical** (diagnostics, safe work procedures, commissioning, documentation), indicating that training should prioritize **job-ready competence and supervised practice**, not only theoretical coverage.
- The current technical gaps are reported most often in **frontline delivery roles** (installers/ O&M technicians), but a substantial share of comments also point to **engineering** and **IT/ data profiles**, reflecting the increasing importance of monitoring/control, interoperability, and data-enabled O&M in RES.

**Question 11:**

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**"What emerging technical skills do you think will become increasingly important in your Renewable Energy System (RES) field within the next 3–5 years?"**

**Q11. Notes and base for synthesis (open-ended):**

- Responses were multilingual; non-English inputs are reflected here in English.
- From the submitted comments, n=97 were coded as substantive (excluding "No / N/A / don't know / punctuation-only" style replies).
- Themes below are non-exclusive (one response may mention multiple gaps), so totals exceed 100%.

Q11 responses are more future-facing and consistently point toward **digitized**, **networked, data-driven RES**. This question captures what stakeholders expect to become **strategically important** for Renewable Energy Technicians and related RES roles over the next 3–5 years. It complements Q10 by shifting from today's "pain points" to **future-facing competence needs**, and the recurring message is that technicians and engineers will need to operate in environments shaped by **smart grids**, a**dvanced storage**, **AI-enabled monitoring**, and **interoperability across devices/vend**ors-with **cybersecurity** becoming increasingly critical.

Indicative recurrence:

- **High recurrence**: AI/data & predictive maintenance; smart grids/microgrids & energy management; interoperability/automation/protocols; storage (BESS/BMS)
- **Medium recurrence**: cybersecurity; circular economy/lifecycle (LCA/LCC, recycling/ repowering); digital twins/simulation/drones/robotics
- **Lower but emerging**: hydrogen; low-carbon materials/retrofit; customer "trusted installer" role

| Q11. Observed Emerging Technical Skills | % (of n=97 ) |
|---|---|
| AI / data analytics / predictive maintenance | 54.7% |
| Smart grids/microgrids/energy management & flexibility | 41.3% |
| Interoperability/communication protocols/automation | 40.0% |
| Energy storage (BESS/BMS) & batteries | 29.3% |
| Cybersecurity (OT/SCADA/IoT) | 24.0% |
| Circular economy / lifecycle / recycling (LCA/LCC) | 24.0% |
| Digital twins / simulation / robotics | 17.3% |
| Hydrogen technologies (value chain & safety) | 10.7% |
| Low-carbon materials & building efficiency (NZEB/heat pumps, etc.) | 4.0% |

### Q11. Synopsis (main themes emerging from the answers):

**A. AI, data analytics & predictive maintenance becoming mainstream: 53** (~54.7%)

- Many respondents foresee increasing need for AI/ML-assisted optimization, anomaly detection, predictive maintenance, and data-driven decision-making in operations.

Illustrative examples*:*

- "AI will be integrated in maintenance and operation-ability to work with AI will be tremendously important."
- "Data analytics and predictive maintenance skills will be essential as IoT monitoring becomes standard."

**B. Smart grids, microgrids, and flexibility/energy management: 40** (~41.3%)

- Future skills include managing intermittency via smart grid operation, microgrids, demand-response logic, and advanced energy management systems.

**C. Interoperability/protocols/automation (SCADA/EMS/RTU/PLC/IoT): 39** (~40%)

- Multiple responses emphasize skills for making devices "talk to each other" (protocols, interoperability, platform integration), including smart home/building contexts.

**D. Energy storage expansion (BESS, advanced batteries, BMS/EMS integration): 28** (~29.3%)

- Storage is repeatedly identified as a growth area (covering installation, safety protocols, network connectivity, and operational optimization)

*Illustrative example:*

- Storage integration (BMS, EMS) and microgrids will become core skills."

E. **Cybersecurity for digital energy infrastructure (OT/SCADA/IoT) ): 23** (~24%)

- Cybersecurity is consistently framed as a rising priority due to digital connectivity of assets: SCADA/OT networks, distributed generation fleets, EV chargers, microgrids.

F. **Circular economy, end-of-life, retrofitting: 23** (~24%)

- Several respondents project increased relevance of recycling PV modules/batteries, eco-design, LCA/LCC, and repowering/retrofitting competences.

G. **Digital twins, advanced simulation, drones/robotics for inspection): 17** (~17.3%)

- "Digital twins" and remote inspection (drones/robotics/ROV) appear in multiple answers-particularly linked to O&M efficiency and offshore/marine contexts.

H. **Hydrogen and new vectors (green hydrogen value chain): 10** (~10.7%)

- Hydrogen was also mentioned in the responses in terms of production, storage, safety, and operations.

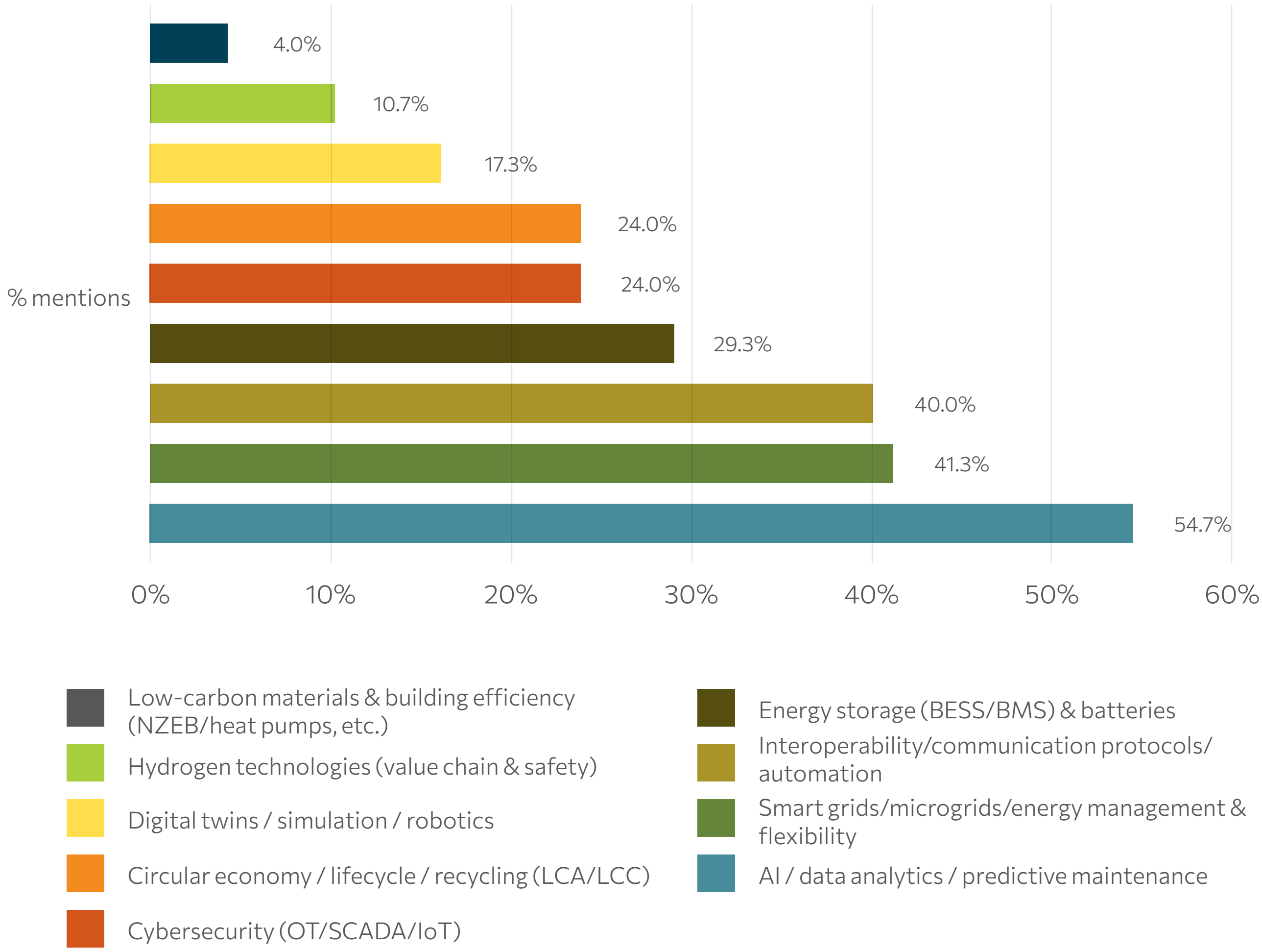
  *Illustrative example:*

- "Hydrogen chain competence and hybrid multi-technology systems will be increasingly important."

I. **Low-carbon/bio-based materials & digital retrofitting 3D scanning: 4** (~4%):

- A small but distinct set of respondents highlighted emerging skills linked to decarbonized construction/retrofit, including working with bio-based/low-carbon materials, deep retrofit execution and quality assurance, and NZEB-aligned installation practices.

## Q11. Observed Emerging Technical Skills




## Q11. Key takeaways from results

Q11 confirms that the RES skills frontier is moving toward **digitalized**, **data-driven**, **and hybrid energy systems**:

- Stakeholders anticipate rising demand for **AI-enabled maintenance and optimization**, **smart grid/microgrid operation**, and **interoperability/automation across multi-vendor systems**.
- **Storage integration (BESS/BMS)** is a core enabling competence, and it is increasingly coupled with **cybersecurity** as RES assets become connected and remotely managed.
- In parallel, respondents consistently anticipate **lifecycle/circular-economy competences** (LCA/LCC, recycling/repowering) as an important sustainability-driven requirement-appearing as often as cybersecurity in this set of responses-while **hydrogen** remains present but lower-frequency.

## Survey Section 3: Microcredentials (Q12–Q13)

### Question 12

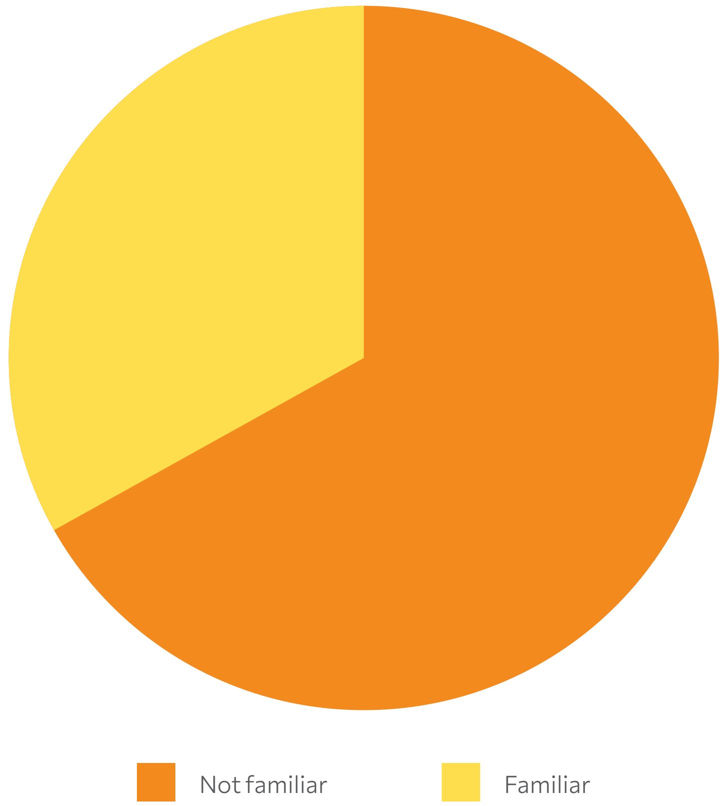
**"Are you familiar with microcredentials?"**

Q12 establishes a baseline level of awareness of microcredentials among respondents. This is important because later questions (Q13–Q15) assume respondents can meaningfully judge value, recognition, and preferred training formats. In an EU-level skills needs analysis, familiarity also helps interpret how "ready" the ecosystem is to adopt microcredentials as an upskilling tool.

### Q12. Results (N=124)

- **Not familiar**: 84 (67.7%)
- **Familiar**: 40 (32.3%)

### Q12. Familiarity with Microcredentials




### Q12. Results synopsis

- Overall, **microcredential awareness is not yet mainstream** in this respondent pool: roughly **two-thirds** report not being familiar.
- This supports the need for a **clear definition, communication strategy, and employer-recognition framing** in later project outputs.
- The results also underline the importance of addressing **recognition and signaling value** (especially for employers), since limited familiarity can reduce uptake even when skills needs are clear.

## Question 13

### Perceptions of microcredentials (only respondents familiar with microcredentials; n=40)

Q13 explores how respondents who are already familiar with microcredentials perceive their usefulness, relevance for digital/green transitions, intent to engage, and (critically) their recognition by employers and institutions.

**Context/base**: In Q12, **40 out of 124 respondents (32.3%)** reported that they are familiar with microcredentials (84 "No"). **Only these 40** proceeded to rate the Q13 statements.
Results below therefore reflect **perceptions among the "aware" subgroup**, not the full sample.

**Scale**: From 'Strongly disagree' (1) to 'Strongly agree' (5)
**Reported metrics**: Mean agreement (1–5), **Top-2-box** (% Agree/Strongly agree), **n=40** for all items.

### Q13. results summary table (n=40)

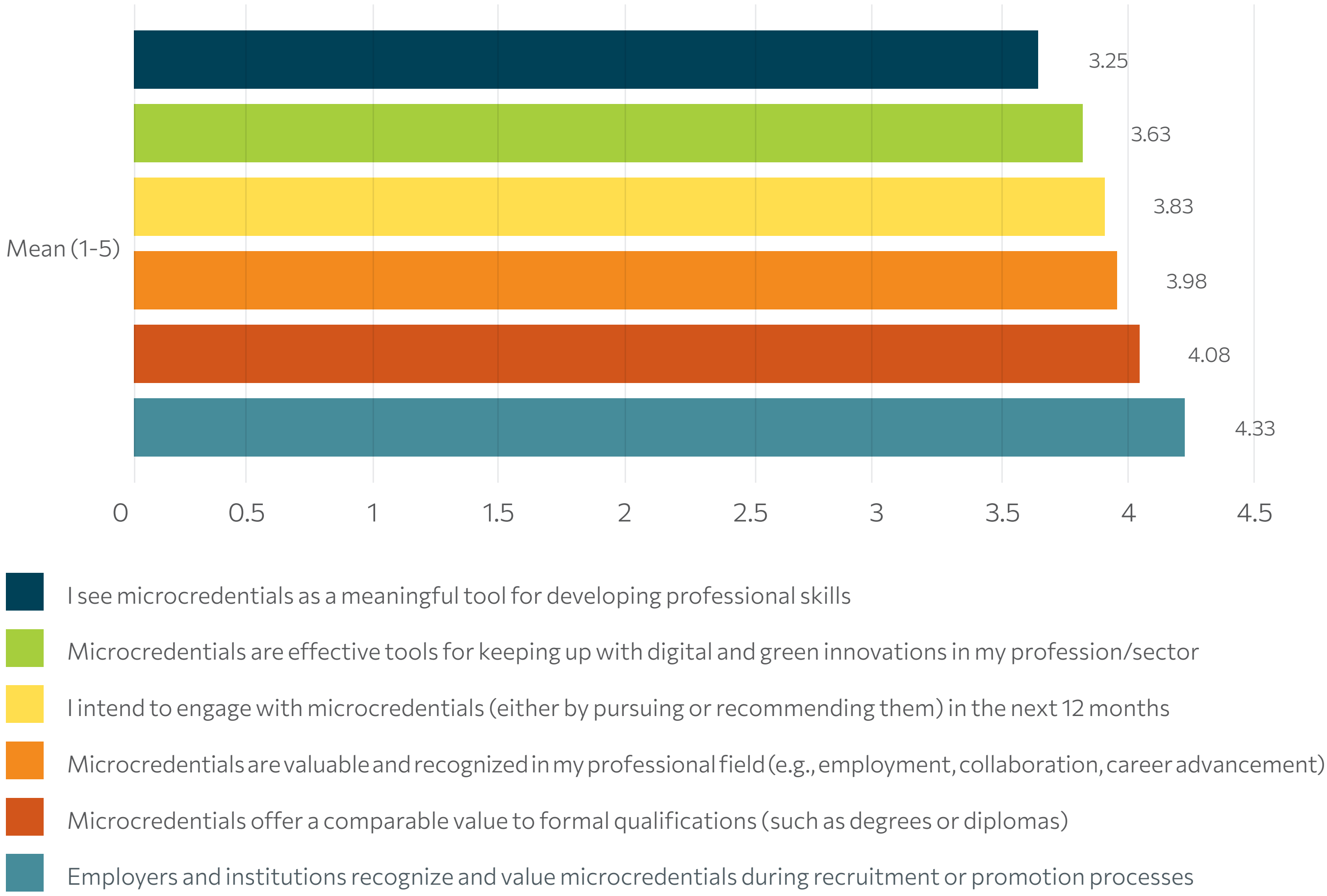
| Q13. Microcredentials statement (n=40) | Mean (1-5) | Top-2% (Agree/Strongly Agree) |
|---|---|---|
| I see microcredentials as a meaningful tool for developing professional skills. | 4.33 | 90% |
| Microcredentials are effective tools for keeping up with digital and green innovations in my profession/sector. | 4.08 | 75% |
| I intend to engage with microcredentials (either by pursuing or recommending them) in the next 12 months | 3.98 | 72.5% |
| Microcredentials are valuable and recognized in my professional field (e.g., employment, collaboration, and career advancement). | 3.83 | 62.5% |
| Microcredentials offer a comparable value to formal qualifications (such as degrees or diplomas) | 3.63 | 62.5% |
| Employers and institutions recognize and value microcredentials during recruitment or promotion processes | 3.25 | 40% |

| Annex Table – Response Distributions (counts and %) Q13. Microcredentials statement (n=40) | Strongly Disagree n (%) | Disagree n (%) | Neutral n (%) | Agree n (%) | Strongly Agree n (%) |
|---|---|---|---|---|---|
| I see microcredentials as a meaningful tool for developing professional skills. | 0 (0%) | 2 (5%) | 2 (5%) | 17 (42.5%) | 19 (47.5%) |
| Microcredentials are effective tools for keeping up with digital and green innovations in my profession/sector. | 2 (5%) | 2 (5%) | 6 (15%) | 13 (27.5%) | 19 (47.5%) |
| I intend to engage with microcredentials (either by pursuing or recommending them) in the next 12 months | 0 (0%) | 2 (5%) | 9 (22.5%) | 17 (42.5%) | 12 (30%) |
| Microcredentials are valuable and recognized in my professional field (e.g., employment, collaboration, career advancement). | 0 (0%) | 4 (10%) | 11 (27.5%) | 13 (32.5%) | 12 (30%) |
| Microcredentials offer a comparable value to formal qualifications (such as degrees or diplomas) | 3 (7.5%) | 6 (15%) | 6 (15%) | 13 (32.5%) | 12 (30%) |
| Employers and institutions recognize and value microcredentials during recruitment or promotion processes | 2 (5%) | 7 (17.5%) | 15 (37.5%) | 11 (27.5%) | 5 (12.5%) |

### Q13. Distribution highlights (what drives the pattern):

- **Very strong perceived usefulness**: “Meaningful tool” is almost universally endorsed (**90%** agree/strongly agree).
- **High transition relevance**: strong agreement that microcredentials help professionals keep pace with **digital and green innovation** (**75%** agree/strongly agree).
- **Positive intention, but not universal**: nearly **3 in 4** intend to engage within 12 months (**72.5%** agree/strongly agree), while **22.5%** remain neutral.
- **Recognition is the bottleneck**: employer/institution recognition is notably weaker (**40%** agree/strongly agree), with a large neutral block (**37.5%**) and **22.5%** disagreeing, suggesting microcredentials may be valued as learning, but **not yet reliably as “currency”** in HR processes.
- **Parity with degrees is mixed**: a majority endorses comparability (**62.5%** agree/strongly agree), but a meaningful minority disagrees (**22.5%**). For positioning, “**complementary/ stackable value**” is likely safer than claiming full equivalence.

## Q13. Microcredentials Statement/Ratings




## Q13. Results synopsis:

- Among those already familiar with microcredentials (n=40), there is strong confidence in their value for professional development and for keeping pace with digital/green change.
- Intent to engage is positive (mean 3.98) but not universal, reflecting a sizeable neutral group.
- However, the survey surfaces a clear recognition gap: perceived usefulness is substantially higher than perceived acceptance in recruitment/promotion. This implies project outputs should prioritize:

  a. quality assurance and transparency of learning outcomes,

  b. **employer engagement and endorsement pathways**, and

  c. **clear signaling/portability** (stackability, alignment to competence frameworks, and job-relevant assessment evidence).

## Survey Section 4: Training Formats & Feedback (Q14–Q15)

### Question 14

**" Preferred training format for upskilling RES Technicians (multi-select: choose exactly 3)"**

Q14 captures *delivery preferences* (how stakeholders want upskilling to be offered). This helps translate the skills priorities (Q6–Q11) into realistic learning pathways and microcredential design choices (format, duration, and workplace integration).

Note: Because respondents selected **exactly three** options, results should be read as **"% of respondents selecting each format"** (percentages do not sum to 100%).

### Q14. Results (ranked by selection share)

Top preferences clearly prioritize **workplace-based learning** and **blended delivery**, complemented by **short modular offerings** (including microcredentials):

1. **Work-based learning (learning on-the-job):** 69 (56.1%)
2. **Blended learning (online + face-to-face):** 52 (42.3%)
3. **Microcredentials (short, certified modules):** 45 (36.6%)
4. **Short online modules (topic-specific):** 44 (35.8%)
5. **Industry-recognized certifications:** 36 (29.3%)
6. **Mentorship/Coaching:** 30 (24.4%)
7. **Peer-to-peer learning:** 28 (22.8%)
8. **Simulated environments (VR/AR):** 27 (22.0%)
9. **Virtual or remote laboratories:** 21 (17.1%)
10. **Self-paced online courses:** 17 (13.8%)

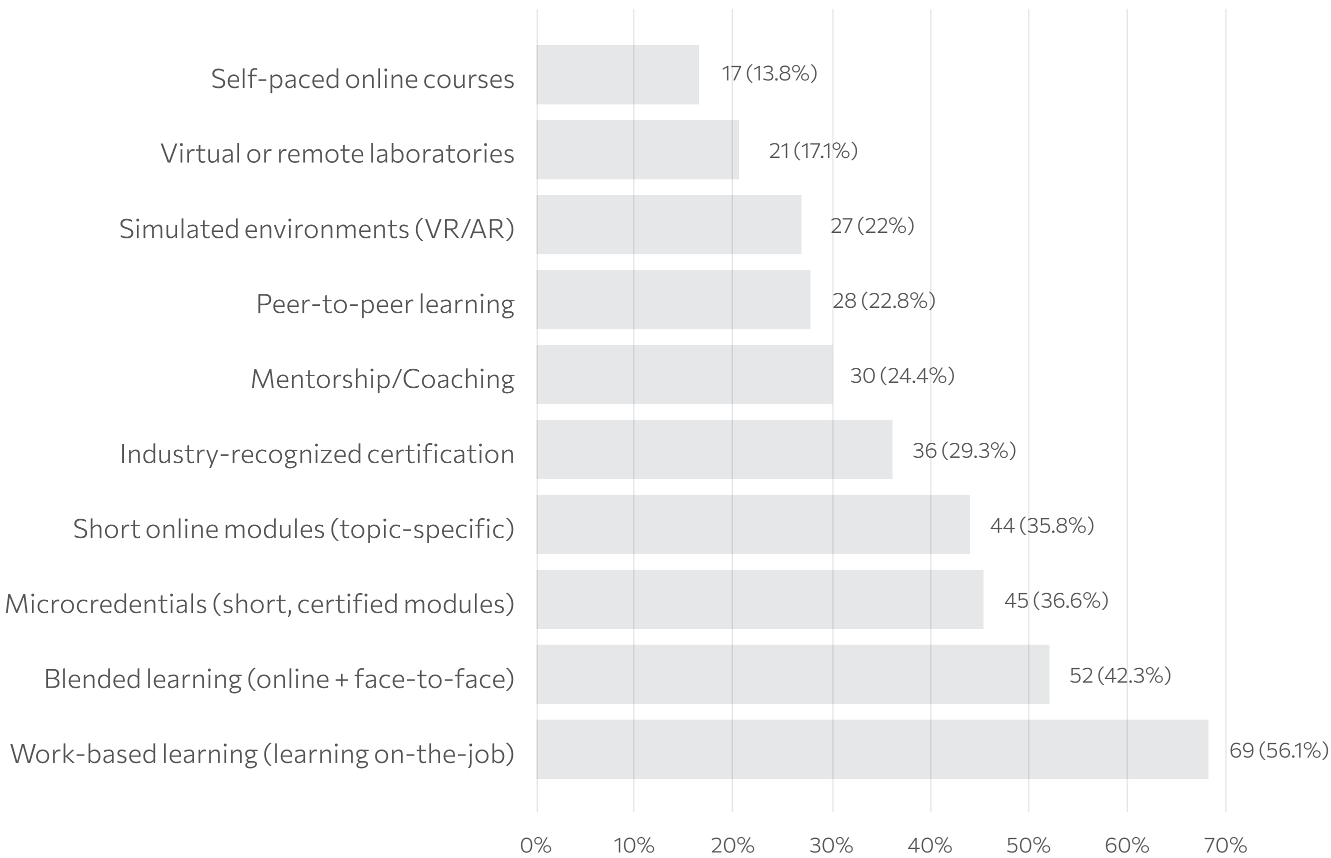
| Q14. Preferred Training Format (select 3 options) | n | % |
|---|---|---|
| **Work-based learning (learning on-the-job)** | **69** | **56.1%** |
| Blended learning (online + face-to-face) | 52 | 42.3% |
| **Microcredentials (short, certified modules)** | **45** | **36.6%** |
| Short online modules (topic-specific) | 44 | 35.8% |
| Industry-recognized certification | 36 | 29.3% |
| Mentorship/Coaching | 30 | 24.4% |
| Peer-to-peer learning | 28 | 22.8% |
| Simulated environments (VR/AR) | 27 | 22% |
| **Virtual or remote laboratories** | **21** | **17.1%** |
| **Self-paced online courses** | **17** | **13.8%** |

*Percentages show the share of respondents selecting each format (multiple selections allowed; each respondent chose 3.

### Q14. Results synopsis/key takeaways

- **Hands-on learning is the strongest signal**: Over half of respondents selected **work-based learning**, suggesting that upskilling should be anchored in *real tasks, equipment, and operational contexts* (installation, O&M, troubleshooting, and safety routines).
- **Blended formats are strongly preferred**: The second-highest preference indicates demand for **structured training that mixes digital flexibility with face-to-face practice**, which is especially relevant for safety-critical and diagnostic skills.
- **Clear appetite for modular "bite-sized" learning: Microcredentials** and **short online modules** are both selected by ~1 in 3 respondents, supporting a pathway design where skills are packaged into focused, stackable units (well-aligned with digital/green upskilling needs identified earlier).
- **Credentials still matter**: Nearly **3 in 10** selected **industry-recognized certifications**, suggesting value in *recognition/portability* alongside learning content.
- **Tech-enhanced practice is "mid-tier" but meaningful: VR/AR, peer-to-peer**, and **remote labs** are selected by **~17–23%**, indicating these are useful enhancers (e.g., safe simulation, remote troubleshooting scenarios) but not the primary delivery backbone.
- **Self-paced-only is the least preferred**: This supports designing self-paced elements as *supporting resources* rather than the main delivery model.

### Q14. Preferred Training Format



Question 15

### Suggested improvements for existing RES technician training programmes

This question captures concrete stakeholder proposals on **how to improve current training provision**, including content, pedagogy, delivery formats, and links to employers/workplaces.

### Q15. Notes and base for synthesis:

- Responses were multilingual, with non-English inputs reflected here in English.
- From the submitted comments, **~93 were substantive** (excluding "No / N/A / don't know / punctuation-only" style replies).
- *Themes below are non-exclusive* (one response can mention multiple improvements), so totals will exceed 100%.

| Q15. Suggested Improvements for existing RES training programs | Mentions (n) | % (of n=93 ) |
|---|---|---|
| More hands-on practice and workplace integration | 35 | 37.6% |
| Stronger integration of digital tools in training | 18 | 19.4% |
| Update curricula for emerging technologies | 13 | 14% |
| More modular/flexible delivery | 11 | 11.8% |
| Shift from "installation only" to system integration and optimization | 9 | 9.7% |
| Clearer assessment and recognized certification | 8 | 8.6% |
| Improved pedagogy and transversal skills | 7 | 7.5% |
| Reinforced safety/HSE | 6 | 6.5% |
| Sustainability and circular economy in practice | 5 | 5.4% |
| Trainer capacity and industry linkage | 4 | 4.3% |

### Q15. Results synopsis (main themes emerging from the answers)

1. **More hands-on practice and workplace integration: 35** (~37.6%)
   Many responses argue current programs are too theoretical and should expand labs, workshops, real installations, and simulated industrial environments-especially for commissioning, troubleshooting, and maintenance task

   Illustrative examples:

   - "More practice on site: real placements and turbine simulators."
   - "Learning should include commissioning, troubleshooting and maintenance tasks-not only installation."

2. **Stronger integration of digital tools in training: 18** (~19.4%)
Stakeholders repeatedly mention digital tooling that technicians increasingly encounter in daily work: **monitoring platforms**, **SCADA/RTUs**, **sensors**, **data interpretation**, **digital twins**, **VR/AR for hazardous scenarios**, etc.

   Illustrative examples:

   - "Add modules on **SCADA/IoT**, alarm interpretation, communication protocols."
   - "Use **digital simulation environments** to support systems thinking."

3. **Update curricula for emerging technologies: 13** (~14.0%)
Respondents frequently propose training that teaches technicians to integrate PV/heat pumps/storage/controls into optimized systems (BMS/HEMS/EMS), tune parameters, interpret performance data, and deliver real efficiency outcomes.

4. **More modular/flexible delivery: 11** (~11.8%)
Respondents propose modular learning pathways (including microcredentials), blended formats, microlearning, and easier participation for working learners-paired with frequent curriculum updates to keep pace with technology.

5. **Shift from "installation only" to system integration: 9** (~9.7%)
Respondents frequently propose training that teaches technicians to integrate PV/heat pumps/storage/controls into optimized systems (BMS/HEMS/EMS), tune parameters, interpret performance data, and deliver real efficiency outcomes.

   Illustrative examples:

   - "Introduce mandatory **system integration** modules (PV/HP; BESS; BMS/HEMS), plus troubleshooting in hybrid systems."
   - "Train technicians to use storage strategically (tariffs, scheduling), not only 'store excess PV'."

6. **Clearer assessment and recognized certification**: **8** (~8.6%)
Several respondents ask for **credible certification**, final exams, and closer alignment with **manufacturer standards** or recognized schemes-so training results are **trusted by employers**.

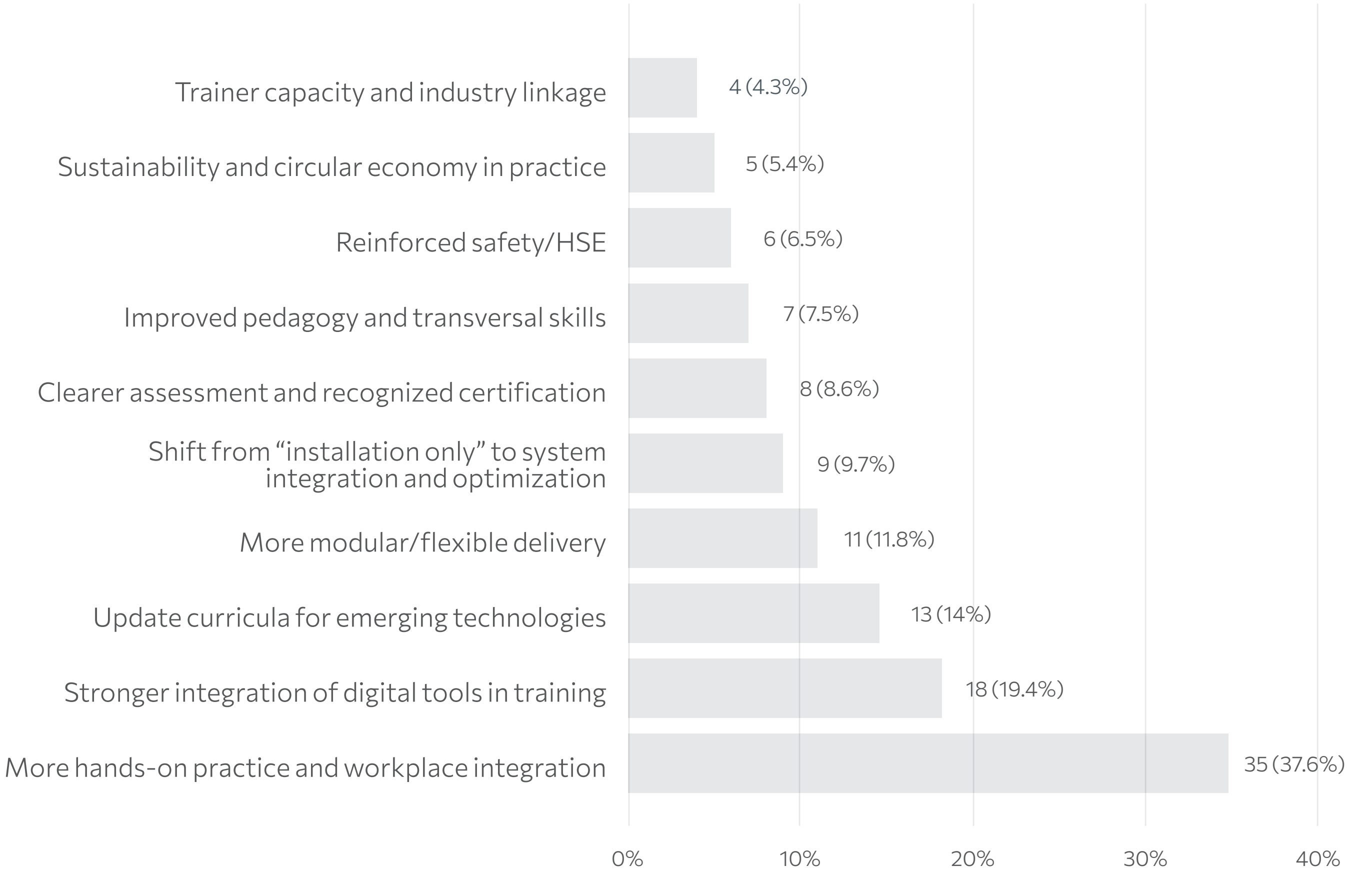
7. **Improved pedagogy and transversal skills**: **7** (~7.5%)
A notable theme is that some trainers lack field experience or up-to-date technology knowledge. Suggested improvements include "train-the-trainer" schemes, short industry placements for educators, and problem-based learning using real cases.

8. **Reinforced safety/HSE** : **6** (~6.5%)
Several responses call for strengthened HSE: lockout/tagout (LOTO), arc-flash prevention, safe measurement on DC circuits, working at height/offshore safety, battery safety, and hydrogen-related hazard logic.

9. **Sustainability and circular economy in practice**: **5** (~5.4%)
Some responses call for stronger coverage of circular economy practices, recycling/end-of-life, LCA thinking, biodiversity/environmental impact, and eco-design; especially where projects require compliance evidence and lifecycle planning.

10. **Trainer capacity and industry linkage: 4** (~4.3%)
    A smaller but important cluster notes that some trainers lack **recent field experience**, and recommends **train-the-trainer**, teacher industry placements, and stronger structured links between training providers and workplace mentors.

### Q15. Suggested Improvements for existing RES training programs




### Q15. Key takeaways from results:

Q15 signals that stakeholders want training that is job-embedded, modular, and certification-linked, with a clear pivot toward system integration, digitalized operations, and safety-critical competence. The findings reinforce a clear direction: stakeholders want RES training to produce **integrator-technicians** who can work safely and effectively in **digitized**, **hybrid systems**, by using monitoring/data tools, configuring controls, and optimizing performance over the asset lifecycle. This directly aligns with earlier findings:

- the **Digital skill needs** (Q6) and **Digital-Green gap examples** (Q8–Q10), and
- the strong preference for **work-based and applied learning formats** (Q14).

These recommendations directly support MICRET's direction: microcredentials and short modules should be designed around real operational tasks (commissioning, monitoring, diagnostics, integration, and safe work), delivered through work-based/blended pathways, and supported by employer-recognition mechanisms.

## 3.3 Cross-question synthesis and conclusions

### What the survey implies for skills development and training design

Across the survey, priorities converge on a technician profile that must be capable of operating safely in digitized, integrated, and performance-driven RES environments. Digital and green competence requirements increasingly overlap with technical O&M realities, reinforcing the need for hybrid competence (technical + digital + sustainability), supported by transversal skills.

1. **Priority skills clusters (EU-level):**

   **Cluster A-Data-enabled operations and maintenance (O&M).**
   Q6 and open-ended responses indicate that technicians increasingly need to use operational data and monitoring tools (including AI/automation-enabled maintenance, monitoring/control systems such as SCADA/IoT/RTU, and performance data interpretation) to optimize performance and diagnose faults, with cybersecurity awareness becoming increasingly relevant as assets become more connected.

   **Cluster B-Efficiency, compliance, and safe work practice.**
   Q7 highlights efficiency optimization and regulatory/safety compliance as baseline green competences, reinforced by Q15's requests for safety-critical, job-ready training (HV/MV/DC risks, procedures, and emergency readiness). Q8 and Q15 also signal rising "lifecycle readiness" needs (circular economy practices and LCA/ESG/carbon reporting awareness), pointing to sustainability documentation and end-of-life responsibilities alongside safety compliance. In parallel, Q10 and Q15 repeatedly raise grid-connection compliance and power-system safety fundamentals (protection concepts, inverter/grid interfaces, safe work in HV/MV environments) as key current gaps.

   **Cluster C-System integration and hybrid systems competence.**
   Q10–Q11 repeatedly frame the gap as the ability to move beyond component installation to integrated system performance (storage integration, microgrids/smart grids, multi-vendor interoperability, commissioning/optimization, and the day-to-day coordination of connected assets). While grid integration remains part of this "system-level" competence, the safety/compliance aspect of grid connection (HV/MV/DC safe practice) is treated under Cluster B.

   **Cluster D-The "adaptive problem solver" profile.**
   Q9 confirms that adaptability and problem-solving are essential transversal competences, supporting effective learning and safe decision-making in complex, changing technical environments.

2. **Training pathway implications (linking Q6–Q11 with Q14–Q15)**

   Training preferences and improvement suggestions align strongly with the skills profile above:

   - Work-based learning as the backbone: respondents most often prefer learning in real work contexts, consistent with the applied nature of the gaps (commissioning, troubleshooting, and safe work).
   - **Blended delivery for scalability**: combining online modules (theory, simulations, and scenario learning) with face-to-face workshops supports both flexibility and practical mastery-especially for safety-critical and diagnostic skills.

- **Modular/stackable microcredentials for fast upskilling**: the combination of **(i)** strong demand for modular formats and (ii) the recognition gap in Q13 suggests that microcredentials should be designed with clear learning outcomes, credible assessment evidence, and employer engagement from the outset.

A practical training architecture suggested by the survey is a three-layer pathway:

1. **Foundation modules:** basic digital literacy for work contexts; safety and compliance; core energy-efficiency practices.
2. **Operational modules:** SCADA/IoT monitoring, data interpretation, commissioning and troubleshooting, and storage basics (BESS/BMS).
3. **Emerging modules:** AI-enabled maintenance/optimization, interoperability and cybersecurity for connected assets, smart grids/microgrids, and hydrogen/circular-economy lifecycle competences where relevant

## 4. How these survey results feed the overall Skills Needs/Gaps Analysis

Per the mixed-methods logic described at the chapter start, the survey provides a prioritized view of perceived needs, which should be triangulated with:

- desk research evidence on labour-market trends and competence frameworks; and
- qualitative insights (focus groups/interviews) to validate feasibility and contextual constraints.

# 04.

Qualitative Research and Analysis

# 4 Qualitative Research and Analysis

## 4.1 Introduction

This chapter analyzes qualitative evidence collected through **focus groups (n=6, incl. one EU-level)** and in-depth expert interviews (n=19), following the MiCRET research protocol.

The qualitative strand complements desk research and the survey by providing **practice-based explanations** of how skill gaps manifest in real work and training contexts, and by clarifying **why** gaps persist (e.g., curriculum lag, workplace constraints, recognition mechanisms).

The dataset is **multilingual**: focus groups and interviews were typically conducted in national languages and synthesized in English to support cross-country comparison. Quotes are included as **short**, **anonymized excerpts**, translated into English where needed, and attributed only by broad role type, in line with protocol requirements on confidentiality and non-identification. Qualitative evidence is **not statistically representative**; it is used to identify recurring themes and plausible explanations to triangulate with the quantitative findings.

### Analytical frame and reporting logic

The qualitative analysis uses a structured thematic approach, organized around MiCRET's four pillars of skills demand:

1. **Digital skills** (e.g., monitoring/control systems, data use, cybersecurity, AI-enabled workflows)
2. **Green skills** (e.g., energy efficiency, compliance, circular economy/lifecycle practices)
3. Soft skills (e.g., adaptability, communication, teamwork, problem-solving in field conditions)
4. **Technical skills** (e.g., commissioning, troubleshooting, grid interface, safety-critical work)

Within each country chapter, findings are synthesized into a **summary table** that captures:

- Key gaps identified
- Current training responses/solutions mentioned
- Future needs/suggested improvements (including microcredentials where relevant)

### Reporting Structure in this chapter

To make national differences visible while still enabling EU-level conclusions, results are presented **country-by-country in alphabetical order**, followed by a **separate EU-level synthesis section** that consolidates shared patterns and workforce-wide implications. The chapter then concludes with:

- **Cross-cutting insights** (themes that recur across countries and pillars), and
- **Recommendations** that translate the qualitative evidence into actionable guidance for training design, delivery formats, and microcredential uptake and recognition.

## 4.2 Qualitative findings per country

### Belgium

No Belgian qualitative contributions (focus group or expert interview reports) were available at the time of drafting. Belgium is therefore included for transparency, but no pecific qualitative findings are reported in this deliverable version. Any late inputs, if received, will be considered for internal triangulation and for informing subsequent project outputs.

### France

Evidence base (France): 1 national focus group (multi-stakeholder) and 3 expert interviews (heat pump sector association, renewable energy trade union, and academic/research).

Participants represented **VET/training provision, sector/industry representation for renewable energy, heat pump ecosystem stakeholders** (installation/maintenance and refrigerant compliance), and **research/academic insight** on skills and innovation.

The French inputs emphasize a **clear "dual transition" reality**, but with unequal digital uptake across company size/segments, and a strong insistence on **fundamentals**, **credible certification**, and **industry-backed training quality.**

## France summary table – Identified skill gaps and training needs

| Key Gaps Identified | Current Training / Solutions | Future Needs/Suggestions |
|---|---|---|
| | **Digital Skills** | |
| • Uneven uptake of digital skills, especially in SMEs and some regions<br>• Gaps in **SCADA/sensors/ data exploitation**, predictive maintenance, and **cybersecurity as part of energy security**<br>• Need for mid-level profiles able to deploy/configure digital interfaces for energy management. | • Digital tools already widely used in several segments (e.g., offshore wind, large-scale assets)<br>• Manufacturer-specific digital tools are increasingly used on sites (tablets/smartphones) and supported by product training. | • Prioritize applied digital micro-learning: monitoring/control tools, data interpretation for O&M, cybersecurity basics for OT/SCADA contexts, and AI applied to optimization/predictive maintenance (with prerequisites). |
| | **Green skills** | |
| • Strong baseline awareness of green transition, but training needs include eco-design, reduction of environmental impact, and understanding societal/ environmental challenges<br>• "Just transition" framing (social acceptability) is increasingly relevant. | • Environmental compliance is reinforced by regulation and audits in some sectors (e.g., refrigerant gases, traceability, and recovery and storage procedures). | • Strengthen eco-design, impact reduction, and "just transition" framing in training<br>• Connect green competences to operational decisions (maintenance choices, life extension/repowering logic). |
| | **Soft skills** | |
| • Need for hybrid profiles combining technical and digital skills and field experience<br>• Internal resistance/age pyramid and organisational change factors can slow digital adoption<br>• Employers need professionals who can adapt to automation levels by role. | • Some ecosystems already use structured certification schemes that build trust and professional responsibility. | • Embed adaptability, teamwork across functions, and "learning-to-learn" approaches into technical upskilling<br>• Ensure training is calibrated by role/ responsibility levels. |
| | **Technical Skills** | |
| • Persistent lack of **core technical fundamentals** (electricity, mechanics, hydraulics, industrial systems)<br>• Strong gaps in plumbing/hydraulic competences in the heat-pump ecosystem<br>• Misconceptions among candidates about system complexity, grid connection and maintenance realities. | • France has a broad training landscape (initial and continuing), and manufacturers provide product-specific upskilling<br>• However, some pathways (especially reconversion) may erode fundamentals. | • Rebalance training: reinforce fundamentals before advanced digitalization.<br>• Expand practice-based modules for installation, commissioning, troubleshooting, and maintenance.<br>• Strengthen specialization where needed (technology-specific). |
| | **Workforce Issues** | |
| • Structural skills shortages: PV installers and wind maintenance technicians<br>• Shortage driven by both candidate availability and skill levels<br>• Risk of quality failures if fast training is not anchored in credible certification. | • Strong reliance on recognized certification frameworks (trust/ insurability/subsidies).<br>• Large but sometimes fragmented training offer (many programmes, variable fit). | • Microcredentials can help **only as complements** to foundational training and recognised certifications<br>• Prerequisites, rigorous assessment, and employer endorsement are essential to avoid low-quality outcomes. |

**Synopsis- Key Takeaways:**
French qualitative inputs describe a sector where the green transition is widely internalized, but the dual transition creates pressure for **credible**, **role-specific upskilling**. A recurring message is that digitalization is accelerating-yet it must be built on **strong fundamentals** and reinforced by **trusted certification/assessment** mechanisms.

- **Digitalization is advancing, but uneven (and cybersecurity becomes central):** Large/automated segments (e.g., offshore wind) are more advanced. SMEs and some regions lag. Remote monitoring/control, predictive maintenance, and cybersecurity are repeatedly flagged as operational priorities.
- **Fundamentals first (technical basics remain a bottleneck)**: Multiple stakeholders stress shortages in electricity/mechanics/hydraulics, and in the heat-pump ecosystem specifically, weak plumbing/hydraulic skills (especially in reconversion pathways).
- **microcredentials are useful only if assessed, prerequisite-based, and aligned with recognized certification**: microcredentials are supported for targeted upskilling (safety, specific procedures, applied digital tools) but cannot replace longer qualifications. Credibility depends on employer endorsement and rigorous evaluation.
- **Soft skills and adaptability underpin digital/green uptake**: French stakeholders stress the need for profiles able to adapt to different automation levels by role, collaborate across functions, and keep learning as technologies and procedures evolve-especially in SMEs and reconversion pathways where change management and communication shape outcomes.

## Greece

**Evidence base (Greece):** 1 national focus group (PV-focused, multi-role discussion) and 2 in-depth expert interviews.

Participants represented **PV field operations and installation contexts**, and inspection/certification and renewables portfolio operations perspectives.

Across Greek inputs, the strongest recurring issues are **safety culture and field discipline, operational digitalization (records/monitoring/telecontrol)**, and **workforce readiness**, with soft skills (problem solving, responsibility, and professionalism) repeatedly described as critical to performance.

## Greece summary table – Identified skill gaps and training needs

| Key Gaps Identified | Current Training / Solutions | Future Needs/Suggestions |
|---|---|---|
| | **Digital Skills** | |
| • Gaps in **digital record-keeping and checklist use** (paper is still common), practical use of monitoring tools (incl. SCADA/remote systems where relevant), and "data-to-decision" capability (especially in portfolio operations).<br>• Limited confidence/experience with AI in operations. | • Internal company seminars<br>• Supplier webinars and manufacturer certifications (e.g., inverter/cloud-related training)<br>• Some organizations increasingly require digital checklists and documentation. | • microcredentials/certifications focused on **practical digital workflows**: digital documentation, monitoring/telecontrol basics, data interpretation for O&M, and AI literacy for operations (with clear prerequisites and assessment). |
| | **Green skills** | |
| • Practical "green" gaps are framed as **environmental management and risk prevention**: waste handling, site cleanliness, fuel/oil handling, and especially **fire prevention** and environmental compliance (ESG awarenes appears as emerging). | • Environmental management via internal procedures (e.g., ISO-driven practices in some firms), safety/environmental briefings, and occasional sustainability-related seminars (e.g., green building/LEED awareness mentioned). | • Strengthen applied training on **fire prevention**, environmental compliance, waste/resource management, and ESG basics tied to day-to-day site work (what to do, what not to do, and why). |
| | **Soft skills** | |
| • Repeated issues: **problem-solving autonomy** (teams escalate issues to office instead of diagnosing in-field), responsibility/safety mindset, communication with suppliers/technical support, and decision-making under pressure (incl. time-critical operations).<br>• Professionalism and a learning mindset in younger applicants are flagged. | • Mostly informal/on-the-job<br>• Some internal training exists (e.g., safety, first aid, working at heights), but soft skills are not systematically trained or assessed. | • Add scenario-based training: **incident handling**, field troubleshooting routines, communication protocols, crisis management, and "learning-to-learn" habits (asking questions, structured escalation). |
| | **Technical Skills** | |
| • Strong emphasis on **safe work practice and technical discipline**: PPE use, method statements/permits to work, HV/MV/DC safety awareness, and basic troubleshooting/diagnostics.<br>• Also highlighted: complex multi-vendor integration issues in PV projects (telecontrol/router/inverter interfacing). | • Internal seminars (working at heights, first aid, safety)<br>• Supplier training (inverters, batteries)<br>• Some recognized certifications exist but can be costly. | • **More hands-on, assessed training**: electrical safety, commissioning, diagnostics, telecontrol/monitoring integration, and structured fault isolation steps (what to test/measure before escalating).<br>• Hybrid delivery and AR/VR are suggested for bridging practice gaps. |
| | **Workforce Issues** | |
| • Recruitment/retention concerns: low motivation for physically demanding field roles among younger workers.<br>• Need for more "first-level support" capacity (field techs, asset managers).<br>• The training market is seen as fragmented/uneven in quality; online-only formats are often ineffective after long field shifts. | • Company-driven training and supplier ecosystem.<br>• Some subsidized programs exist, but engagement/format is questioned.<br>• Global association certifications are valued but expensive. | • Practical, modular pathways plus stronger employer/institution recognition.<br>• Strengthen school–work alternance and mentoring. |

**Synopsis/ Key Takeaways:**

Greek qualitative inputs strongly emphasize **field safety discipline, practical digitalization**, and **workforce readiness** in PV-heavy contexts, with repeated references to the need for technicians who can operate autonomously and responsibly in real conditions.

- **Safety culture and safe work practice remain the most immediate gap**: Personal protective equipment use, method statements/permits-to-work, and disciplined adherence to procedures are described as improving but still inconsistent, especially under time pressure in field projects.
- **Digitalization is practical and operational (records → monitoring → telecontrol)**: the main need is not advanced programming but using digital checklists/records, understanding monitoring/remote systems, and handling multi-vendor interoperability issues in real installations.
- **Soft skills are a performance bottleneck (autonomy, problem solving, and communication)**: teams often escalate issues instead of diagnosing them in the field; a responsibility mindset, structured communication with suppliers/support, and decision-making under uncertainty are repeatedly highlighted as gaps.
- **Training direction: microcredentials can work if practice-based and certified**: Stakeholders support short, targeted learning units (including manufacturer-style credentials) **only if** they include credible assessment, are backed by recognized bodies, and use hybrid/interactive formats that fit field realities.

## Italy

**Evidence base (Italy)**: 1 national focus group (Renewable Energy Communities/CER) and 4 in-depth expert interviews.

Participants represented **renewable energy communities (CER) stakeholders**, **energy managers/system integration perspectives**, and **training/education-linked viewpoints** around skills development and workforce readiness.

The Italian inputs frame RES work as a **socio-technical ecosystem** where energy know-how intersects with **community governance**, **funding/incentives**, **and documentation requirements**, not only technology delivery.

## Italy summary table – Identified skill gaps and training needs

| Key Gaps Identified | Current Training / Solutions | Future Needs/Suggestions |
|---|---|---|
| **Digital Skills** | | |
| • Priority is **functional digital literacy**, not advanced coding: data management, interpreting digital outputs/dashboards, and **critical/reflective use of AI** for reporting/documentation. | • Increasing use of digital tools and AI for project drafting/reporting, but concerns about **uncritical use** without solid fundamentals. | • Build digital competence around real tasks: monitoring, interpretation, documentation quality, and supplier/distributor coordination.<br>• Strengthen AI literacy as "support, not substitute." |
| **Green skills** | | |
| • Strong emphasis on **regulatory framework** (e.g., CER/RED II context) plus ability to integrate **sustainability and social justice criteria** and **impact assessment** into projects. | • Sustainability is often treated as a **tender requirement**, with uneven depth of implementation.<br>• Compliance/certification culture is seen as underdeveloped in training. | • Strengthen applied "green" practice: impact assessment (social/environmental/economic), sustainability documentation/ quality systems, and better project "dimensioning" logic. |
| **Soft skills** | | |
| • Shortage of **hybrid profiles** combining energy and community and governance/management.<br>• Need for facilitation, stakeholder engagement, and "value narration" of projects. | • Some community learning/ workshop formats reported via university-supported initiatives. | • Embed communication/facilitation into technical upskilling.<br>• Use scenario/problem-based learning linked to local cases and community contexts. |
| **Technical Skills** | | |
| • Gap between **theoretical preparation and field application; weak energy fundamentals** (e.g., sizing, reading production/ consumption data)<br>• System-level thinking beyond single components. (e.g., sizing, reading production/consumption data). | • Some initiatives exist but are **inconsistent and context-dependent**.<br>• Stronger results are reported where learning is linked to lab **work/prototypes**.<br>• Learning is linked to lab **work/prototypes**. | • More **practice-oriented learning** with structured workplace linkage (case work, site visits, and job shadowing).<br>• Focus on fewer topics with more depth. |
| **Workforce Issues** | | |
| • Training is often seen as **too theoretical**, **fragmented**, and **weakly linked to practice**, especially for new entrants.<br>• Need for inclusion (youth, women, small entities). | • Microcredentials are already viewed positively in principle.<br>• University involvement can support access and scale. | • Practical, modular pathways plus stronger employer/institution recognition.<br>• Strengthen school–work alternance and mentoring. |

**Synopsis/ Key Takeaways**

Overall, Italian qualitative inputs emphasize a shift from "component installation" to **system-level performance**, where technicians and adjacent roles must combine **applied technical competence**, **operational digital literacy**, and **regulatory/sustainability awareness**-especially in the context of **Renewable Energy Communities (CER)**.

- **Applied technical competence (theory → practice gap)**: The dominant issue is not lack of theory, but difficulty applying knowledge on-site (sizing, commissioning, troubleshooting, translating data into decisions).
- **Digital skills as operational literacy (not heavy coding)**: Needs focus on using and interpreting tools and outputs (dashboards, monitoring data, documentation quality), with growing attention to AI literacy as a support tool requiring critical judgement.
- **Green skills anchored in compliance, impact, and social legitimacy**: "Green" is framed as the ability to deliver compliant and fundable projects (CER context), including impact awareness and fairness considerations alongside sustainability requirements.
- **Training direction: modular, practice-based pathways (microcredentials if recognized)**: Stakeholders support microcredentials and short modular learning **only if** they are hands-on, linked to field practice, and carry credible recognition/portability.

## The Netherlands

**Evidence base (Netherlands):** 1 national focus group + 3 expert in-depth interviews.

Participants represented **policy/governance and education–industry coordination** (microcredential pilots and regulatory/recognition perspectives), **VET/training provision and learning community practice**, and **wind energy sector training** (maintenance-oriented modular upskilling).

Dutch inputs emphasize that practice is moving fast (microcredentials are already in use), while **recognition**, **leveling**, **metadata**, and **governance** still create friction-alongside a strong push for **modular**, **practice-based training** that is directly readable by employers.

## Netherlands summary table – Identified skill gaps and training needs

| Key Gaps Identified | Current Training / Solutions | Future Needs/Suggestions |
|---|---|---|
| | **Digital Skills** | |
| • Digital needs are framed mainly as **operational hands-on competences** (monitoring/communication systems, sensors, troubleshooting tools) rather than "digital skills" as a separate demand category.<br>• Level/metadata visibility limits clear signalling of digital competence via microcredentials. | • Wind sector training already integrates digital elements in practice.<br>• Modular provision is delivered via hybrid formats, including VR for safe practice. | • Make operational digital competence **explicit in learning outcomes**, assessed and portable.<br>• Improve visibility/standardization of metadata (incl. level/credits where possible) to strengthen recognition and comparability. |
| | **Green skills** | |
| • Stakeholders report limited explicit demand framed as "green skills" (often embedded in tasks) strong relevance of green themes (circularity/green education value chains), but translation into recognizable credentials depends on governance and quality framing. | • Environmental management via internal procedures (e.g., ISO-driven practices in some firms), safety/environmental briefings, and occasional sustainability-related seminars (e.g., green building/LEED awareness mentioned). | • Strengthen applied training on **fire prevention**, environmental compliance, waste/resource management, and ESG basics tied to day-to-day site work (what to do, what not to do, and why). |
| | **Soft skills** | |
| • Strong qualitative emphasis on **learning-to-learn**, curiosity, initiative, adaptability, and metacognitive skills as prerequisites for coping with innovation.<br>• Co-creation requires communication and collaboration capacity. | • Learning communities use co-creation models and scenario work to help learners and companies anticipate innovation and translate it into training demand. | • Embed soft skills explicitly in microcredential design (clear outcomes and assessment evidence), especially around adaptive learning, teamwork, and problem-solving in innovation contexts. |
| | **Technical Skills** | |
| • Wind sector shift from installation to maintenance creates an urgent need for modular maintenance skills.<br>• Lack of a widely recognized, sustainable skills standard for wind technicians across contexts (onshore/offshore). | • Companies such as SCADA developed **10 short training modules** for entry-level wind turbine technicians.<br>• Delivered in hybrid formats (online + VR + physical practice). | • Strengthen European-level standardisation and portability: stackable modules/microcredentials with clear "can-do" outcomes.<br>• Align recognition mechanisms across borders. |
| | **Workforce Issues** | |
| • Core bottlenecks are **policy–practice gaps**: legal constraints on public display of level indication, metadata issues, unclear ownership/awarding bodies, and risk of fragmentation/proliferation.<br>• Employers value "reliable, recognisable competence" more than labels.<br>• Online-only formats often ineffective after long field shifts. | • Microcredentials already developed at scale.<br>• The quality framework provides a shared reference point.<br>• Initiatives run through LLL Catalyst and public–private partnerships (CoVEs). | • Improve governance: clarify roles (policy direction without overregulation), enable functional recognition (level/credits/metadata), and use QA frameworks to limit fragmentation while supporting co-creation. |

**Synopsis/ Key Takeaways:**

Dutch qualitative inputs frame microcredentials as a **structural lifelong learning instrument** developing faster in practice than in policy, with the strongest emphasis on **recognition mechanisms**, **co-creation with industry**, and **modular practice-based training** (especially in wind maintenance).

- **Digital (operational, task-embedded):** Digital competence is described as practical capability with monitoring/communication systems, sensor tech and troubleshooting tools-often embedded in daily tasks rather than requested explicitly as "digital skills".
- **Green (embedded, but needs clearer signaling):** Green themes (e.g., "green education", and circularity) are prominent in initiatives, but their labour-market value depends on how clearly they are expressed as outcomes and recognized across systems.
- **Soft (learning-to-learn as the key enabler):** A strong recurring message is that employers want people who can learn and adapt-curious, initiative-taking profiles able to cope with innovation-making soft skills a foundation for all pillar upskilling.
- **Technical/system (modular maintenance + recognition bottlenecks):** The wind sector urgently needs modular maintenance skills, and microcredentials are seen as promising-yet recognition and standardization remain the challenge (level visibility, civil effect, ownership, metadata).

## Portugal

**Evidence base (Portugal):** 1 national focus group and 4 expert in-depth interviews.

Stakeholders represented include **VET school leadership and national education policy representation**, **VET provider leadership and sector association perspective**, **industry training coordination (wind sector/ O&M context)**, and a t**raining coordinator for PV installer technicians**, alongside a l**earner-focused focus group** (future technicians) reflecting early-career perspectives on the twin transition and training needs.

Portuguese inputs emphasise rapid "twin transition" pressures (digital and green), but also a persistent bottleneck in **training capacity** (labs, equipment, trainers) and **foundational readiness** (electricity basics, autonomy/critical reasoning), making **modular, practice-based microcredentials** a strong fit-if integrated with recognised qualification systems and strong work-based learning.

## Portugal summary table – Identified skill gaps and training needs

| Key Gaps Identified | Current Training / Solutions | Future Needs/Suggestions |
|---|---|---|
| | **Digital Skills** | |
| • Increasing need for **remote monitoring and real-time data interpretation**, dashboards/ platform use, IoT/sensor integration, basic programming for automation/ parameterization, and cybersecurity for energy infrastructures.<br>• CAD/BIM and modeling appear as relevant in PV/wind installation contexts. | • Companies request training in applied tools (e.g., Excel/Power BI, programming/data analysis/AI).<br>• Some VET providers update curricula and strengthen labs through partnerships. | • Make digital competence **task-based and assessed**: monitoring/SCADA literacy, data-to-decision routines, cybersecurity basics, and applied CAD/BIM/simulation where relevant.<br>• Use short, stackable modules with practical evidence. |
| | **Green skills** | |
| • Strong emphasis on **energy efficiency**, environmental compliance (licensing/operation), waste management/circular economy, safe/sustainable installation practices, and **environmental impact and life-cycle** thinking (LCA).<br>• ESG/CSRD-type reporting awareness appears as emerging in training contexts. | • Compliance is present in sector practice.<br>• Some programmes have progressed, but interviewees note incomplete preparation for emerging green/digital roles and the need for continuous curriculum updating. | • Strengthen applied green practice (efficiency monitoring, compliance routines, circular economy procedures, impact/lifecycle basics) and connect it to daily technical decisions and documentation. |
| | **Soft skills** | |
| • Recurrent gaps: **autonomy**, critical reasoning in real contexts, and adaptability/learning-to-learn.<br>• Technical English is also flagged as enabling competence (manuals/ standards).<br>• Some employers stress transversal skills as a recurring weak point. | • Mentoring/onboarding and workplace learning are used (company investment in training from onboarding, mentoring projects). | • Embed soft skills explicitly into training (problem-based learning, troubleshooting routines, teamwork/communication), and require evidence (observed practice, scenario tasks).<br>• Include technical English where relevant. |
| | **Technical Skills** | |
| • Persistent weaknesses in **basic electricity** and applied diagnostics.<br>• Limited access to state-of-the-art equipment reduces hands-on readiness.<br>• Need for technicians able to work on distributed systems (energy communities/self-consumption) with practical installation/ maintenance competence. | • VET programmes have progressed.<br>• Schools report curriculum updates and lab reinforcement, but technological change outpaces review cycles. | • Rebalance training: fundamentals first (electricity), then advanced systems (storage, hydrogen, smart microgrids).<br>• Increase practical lab/simulator hours and work-based learning. |
| | **Workforce Issues** | |
| • Structural constraints: curriculum update cycles lag, shortage of specialised trainers, and rapid equipment obsolescence occurs; employers struggle to find **hybrid profiles** combining green + digital + technical competence.<br>• Training effectiveness and ROI are concerns in firms. | • Strong school–company partnerships and project-based learning are described as effective.<br>• Participation in European networks (e.g., Erasmus+) supports trainer upskilling and innovation. | • Implement a coherent microcredential system integrated with national qualifications.<br>• Invest in modern labs/equipment and trainer upskilling.<br>• Strengthen regional platforms for continuous needs assessment and co-designed modules. |

**Synopsis/ Key Takeaways:**

Portuguese qualitative inputs describe a fast-moving twin transition that requires technicians to combine **operational digital competence**, **applied sustainability practice**, and **job-ready fundamentals**, while training systems face capacity constraints (labs, equipment, trainers), making **short, modular, and work-linked microcredentials** highly relevant.

- **Digital (operations are becoming fully digitalized):** Stakeholders anticipate SCADA/IoT, smart microgrids, drones/ remote inspection, dashboards, and real-time analytics as core technician capabilities, alongside emerging cybersecurity needs.

- **Green (efficiency, compliance, and circular economy/ lifecycle):** The strongest green signal is practical: efficiency assessment/monitoring, environmental compliance, circular economy, and waste management, with impact/life-cycle thinking increasingly expected.

- **Soft (autonomy and critical reasoning are recurring gaps):** Across education and employers, the recurring soft-skill bottleneck is autonomy and critical reasoning in real work contexts (plus enabling technical English for standards/manuals).

- **Technical/system (fundamentals + training capacity constraints → modular solutions):** Gaps in basic electricity and limited hands-on access to modern equipment persist while technology evolves faster than curricula-supporting modular, practice-based upskilling and strong school–company partnerships.

## EU level - Qualitative findings (Focus group and In-depth Interviews)

**Evidence base (EU-level)**: 1 EU-level focus group + 3 expert in-depth interviews.

Stakeholders represented include **offshore wind service/O&M roles** within a large wind OEM (apprentice management, team leadership, service administration), plus cross-border experts working in **battery storage development and permitting, renewable energy project development in the built environment/energy transition**, and **energy research on flexibility and green hydrogen** (with experience delivering AI/digital-skills workshops for educators).

EU-level inputs emphasize that practice is rapidly shifting toward **software-driven**, d**ata-intensive RES operations**, but training systems and recognition mechanisms still lag-creating strong demand for **modular**, **industry-endorsed microcredentials** delivered in **blended**, **work-compatible formats**.

## EU-level summary table – Identified skill gaps and training needs

| Key Gaps Identified | Current Training / Solutions | Future Needs/Suggestions |
|---|---|---|
| **Digital Skills** | | |
| • Strong shift from mechanical to **software-driven systems** and remote diagnostics<br>• Gaps in **data interpretation** (dashboards/ analytics), **AI literacy** (responsible use), cybersecurity awareness for critical infrastructure, and advanced digital tools such as **BIM/digital twins** and data analysis (e.g., Python/MATLAB in some contexts). | • Companies increasingly use digital checklists, dashboards, internal platforms, and pilot AI tools (e.g., Copilot) for workflow/ knowledge management<br>• On-the-job learning remains essential. | • Prioritise task-based digital modules: data-to-action troubleshooting, monitoring/ remote systems, AI literacy and critical evaluation, cybersecurity basics for OT/ SCADA contexts<br>• Include BIM/digital twins where relevant. |
| **Green skills** | | |
| • Practical "green" competence: waste/hazardous materials handling, spill prevention, lifecycle thinking, and aligning operational decisions (e.g., travel/logistics choices) with footprint reduction.<br>• Broader sustainability competence includes **ESG awareness** and resource-efficient project development. | • Strong organizational sustainability targets (carbon neutrality, waste systems) exist in some sectors; green practices are embedded in procedures/ risk assessments. | • Strengthen applied green skills tied to daily practice: lifecycle impact of parts, safe materials handling, resource/ waste management, and ESG basics connected to operational documentation. |
| **Soft skills** | | |
| • Cross-cutting need for communication and "translation" skills: explaining complex energy concepts to non-experts, advising end-users, and communicating sustainability decisions.<br>• Also critical thinking/ethics in AI use and motivation/engagement as hiring challenges. | • Some workshops and webinars support continuous learning.<br>• Industry events and associations contribute to upskilling. | • Embed communication and advisory skills into technical upskilling; develop "critical AI use" behaviours (when to trust/verify outputs).x<br>• Scenario-based training for decision-making and stakeholder interaction. |
| **Technical Skills** | | |
| • Training systems are strong in "core technical skills" but lag on applied mathematics/physics and modern engineering foundations needed for digitalized assets.<br>• The workforce needs modular entry pathways (tools, electricity, hydraulics, and safety) plus role-specific specialization. | • Apprenticeships and on-the-job learning are viewed as effective.<br>• Technical core training exists but varies in relevance and modernity. | • Develop modular/stackable training that closes fundamental gaps and links directly to new operational realities (data, remote diagnostics, automation). |
| **Workforce Issues** | | |
| • Key system bottlenecks: curriculum lag vs industry change.<br>• Shortages of trainers with modern RES experience.<br>• Fragmented "renewable" programmes that lack specific competencies.<br>• microcredentials need industry endorsement and credibility to influence hiring.<br>• EU-wide suggestion: common core curriculum + national adaptation (e.g., 80/20).<br>• Need for more "first-level support" capacity (field techs, asset managers).<br>• The training market is seen as fragmented/uneven in quality.<br>• Online-only formats are often ineffective after long field shifts. | • Growing use of webinars/ blended learning.<br>• Microcredentials seen as a promising signal (analogous to major tech certifications) and a potential hiring filter when linked to job roles. | • Strengthen microcredential governance: quality assurance, clear outcomes, stackability, and cross-border recognition (industry bodies / skills councils).<br>• Use blended delivery to fit technician time constraints. |

**Synopsis/ Key Takeaways:**

EU-level qualitative inputs converge on a clear message: RES work is becoming **data-driven**, **remotely monitored**, **and digitally mediated**, which increases demand for **operational digital skills**, **practical sustainability practice**, and **hybrid competences** (technical + digital + communication), supported by **industry-endorsed microcredentials**.

- **Digital (data + AI + cybersecurity as baseline)**: Digital literacy is no longer optional; technicians increasingly need to interpret dashboards, use remote diagnostics, and develop AI literacy and cybersecurity awareness for critical infrastructure.
- **Green (lifecycle-anchored sustainability in daily work)**: Sustainability is framed as operational behaviour and procedure-materials handling, waste control, spill prevention, and lifecycle impact awareness-alongside broader ESG/resource-efficiency expectations.
- **Soft (communication + critical thinking for the twin transition)**: EU-level experts stress that technical solutions fail without communication and advisory skills; additionally, responsible/critical AI use is required as AI becomes widespread in education and work.
- **Technical/system (microcredentials need endorsement and blended delivery):** Microcredentials are viewed positively as modular upskilling-especially when industry-endorsed-but must be delivered in blended formats and aligned to common standards (with scope for national adaptation) to be trusted in hiring.

## 4.3 Cross-country synthesis

This section compares qualitative findings across the participating countries (Italy, France, Greece, Netherlands, and Portugal). Results are reported at **EU level**, highlighting (a) themes that **converge across countries** and (b) themes that **differ by national context and stakeholder mix**. Belgium is included for transparency but had **no qualitative contributions** at the time of reporting.

**Important note on "EU-level" evidence**: An EU-level focus group and EU-level expert interviews are presented as a **separate stakeholder lens** (see relevant subsection below). They are used to triangulate and validate cross-country patterns and to surface cross-border enabling conditions (e.g., recognition, portability, QA). They are not treated as a country and are not included in the country comparison matrix.

### What converges across countries

Across all contributing countries, qualitative evidence points to a common "next-generation technician" profile shaped by the **twin transition**:

1. **Digital skills are increasingly operational and O&M-oriented (data-to-decision).**
Across contexts, "digital" is framed as the ability to **use monitoring/records, interpret performance data**, **and troubleshoot digitally mediated systems**, rather than heavy programming. This aligns with the survey's emphasis on adaptability to new tools, data analysis, monitoring/control systems, and cybersecurity (Q6), and with open-ended survey themes on SCADA/EMS, analytics, and AI-enabled maintenance (Q8–Q11).

2. **Safety, compliance, and grid-interface discipline remain foundational.**
Safety culture (HV/MV/DC risks, procedures, emergency readiness, PPE) and compliance routines appear repeatedly-especially pronounced in Greece and France, but present across all contexts. This triangulates strongly with survey signals that "follow regulations & safety standards" and "energy efficiency optimization" are top green priorities (Q7), and with training improvement requests calling for more practical safety and job-ready training (Q15).

3. **Fundamentals and practice-based competence are a recurring bottleneck.**
Multiple countries stress gaps in "basics" (electricity, hydraulics, diagnostics) and the **theory-to-practice gap**, particularly for new entrants or reconversion pathways. This corroborates the survey's Q10 technical gaps emphasis on job-critical competence (diagnostics, monitoring/control, grid integration, system integration).

4. **microcredentials are seen as promising-if quality-assured, assessed, and recognized.**
Across countries, support for microcredentials is conditional: they should be **modular, stackable, practice-based**, and recognized by employers/institutions. This directly mirrors the survey's microcredential pattern: high perceived usefulness among the aware subgroup (Q13) but weaker perceived recognition in recruitment/promotion (Q13), and the demand for work-based/blended learning (Q14–Q15).

5. **Soft skills are treated as performance enablers, not "nice-to-haves."**
Even when not labelled "soft skills," recurring needs include **autonomy, problem solving, communication, learning-to-learn, and teamwork across functions**. This triangulates with Q9 (adaptability and problem-solving profile) and with qualitative evidence that work increasingly requires hybrid coordination (technical + digital + compliance + stakeholder interaction).

## Table of Cross-country Qualitative Synthesis (EU-level executive summary)

| EU-level convergent insight | Country "accents" | Future Needs/Suggestions |
|---|---|---|
| | **Digital Skills** | |
| • Digital needs are framed as operational, task-based capabilities: monitoring/records, data interpretation, remote/connected systems, and growing cybersecurity relevance. | • NL (digital embedded and signalling/metadata)<br>• GR (records → monitoring/ telecontrol)<br>• PT (SCADA/IoT/data/cyber)<br>• FR (uneven uptake SMEs vs large)<br>• IT (functional digital literacy and AI caution). | • Prioritise task-based digital modules: data-to-action troubleshooting, monitoring/ remote systems, AI literacy and critical evaluation, cybersecurity basics for OT/SCADA contexts<br>• Include BIM/digital twins where relevant. |
| | **Green skills** | |
| • Practical "green" competence: waste/hazardous materials handling, spill prevention, lifecycle thinking, and aligning operational decisions (e.g., travel/logistics choices) with footprint reduction.<br>• Broader sustainability competence includes ESG awareness and resource-efficient project development. | • IT (CER/regulation and impact legitimacy)<br>• PT (efficiency/compliance/ circularity)<br>• GR (environmental management/ fire prevention)<br>• FR (eco-design/impact reduction)<br>• NL (green embedded-needs clear outcomes). | • Embed green skills into practical modules: efficiency optimization routines, compliance checklists, waste/circular procedures, and basic LCA/ESG awareness where relevant. |
| | **Soft skills** | |
| • Soft skills are treated as performance enablers: autonomy, problem-solving, communication, and learning-to-learn—especially in complex, changing field contexts. | • NL (learning-to-learn/curiosity)<br>• GR (autonomy, escalation discipline)<br>• PT (autonomy/critical reasoning)<br>• IT (hybrid facilitation/ community roles)<br>• FR (adaptability in reconversion/ SME contexts). | • Include scenario/problem-based learning and explicit assessment of soft skills (structured troubleshooting reporting, teamwork tasks, communication protocols, and critical AI use). |
| | **Technical Skills** | |
| • Persistent emphasis on fundamentals and job-ready practice: electricity/mechanics/ hydraulics, diagnostics, commissioning, safe work<br>• Shift from installation to O&M/ system performance. | • FR (fundamentals; heat-pump ecosystem)<br>• GR (safe work discipline + diagnostics)<br>• PT (basic electricity + advanced systems)<br>• NL (wind maintenance modularisation)<br>• IT (system-level performance and integration). | • Rebalance curricula: fundamentals → applied practice → specialization.<br>• microcredentials best used for specific tasks (commissioning, diagnostics, safety procedures, manufacturer systems). |
| | **Workforce Issues** | |
| • Training systems lag behind industry change: trainer readiness, equipment/labs, recognition mechanisms, and risk of fragmentation without QA. | • NL (recognition/levelling/metadata governance)<br>• PT (labs/trainers/curriculum cycles)<br>• FR (skills shortages + certification trust)<br>• GR (recruitment/format fit)<br>• IT (ecosystem/governance/ incentives context). | • microcredentials must meet "credibility conditions": **clear outcomes**, **QA**, **assessment**, **employer endorsement**, **portability metadata**, **stackability** into qualifications<br>• Use blended formats compatible with working schedules. |

## What differs by country context

While the overall direction is shared, each country highlights particular "pressure points":

- **Netherlands**: strongest emphasis on **microcredential governance and recognition conditions** (leveling/metadata/ownership, avoiding fragmentation), plus learning communities/co-creation and modular wind maintenance pathways.
- **Greece**: strongest emphasis on **field safety culture**, operational discipline, and soft-skill bottlenecks in troubleshooting autonomy; practical digitalization through records/monitoring/telecontrol is central.
- **France**: strong emphasis on **foundational technical competence** (electricity/mechanics/hydraulics), credible certification structures, and uneven digital uptake between large/automated segments and SMEs.
- **Italy**: distinctive emphasis on **RES as a socio-technical ecosystem**, especially CER contexts requiring governance, incentives, documentation, and stakeholder legitimacy (hybrid profiles).
- **Portugal**: strong emphasis on **training system capacity constraints** (labs/equipment/trainer readiness), and the need to combine fast-evolving digital/green needs with solid fundamentals; strong support for modular, practice-based pathways integrated with qualification systems.
- **Belgium:** no qualitative inputs available in this reporting cycle.

### Table of Country "accents" (what differs most by context)

| Country | Most distinctive emphasis (2–3 points) |
|---|---|
| France | • Fundamentals (electricity/mechanics/hydraulics)<br>• Certification credibility<br>• Uneven digital uptake (SMEs)<br>• Workforce shortages/quality risk. |
| Greece | • Safety culture + field discipline<br>• Operational digitalisation (records/monitoring/telecontrol)<br>• Autonomy/problem-solving bottlenecks in troubleshooting. |
| Italy | • CER / socio-technical ecosystem (governance, incentives, legitimacy)<br>• Functional digital literacy and AI caution<br>• Hybrid community-facing profiles. |
| Netherlands | • microcredential governance (metadata/levelling/ownership, avoiding fragmentation)<br>• Co-creation/learning communities<br>• Modular wind maintenance pathways. |
| Portugal | • Training capacity constraints (labs/equipment/trainers) and fast twin transition<br>• SCADA/IoT/data/cyber<br>• Strong demand for modular, work-linked pathways |
| Belgium | • No qualitative inputs available at drafting time (reported as a data availability note). |

Note: EU-level evidence is used to validate and frame EU-wide implications; it is not included in the country salience matrix to avoid double-counting or mixing levels.

### EU-level stakeholder lens

EU-level qualitative evidence (EU focus group + EU interviews) is used here as a triangulation layer to (a) confirm the direction of cross-country findings and (b) highlight EU-wide enabling conditions.

What EU-level inputs confirm (alignment with country convergence):

- RES operations are becoming **data-driven and software-mediated**, increasing the importance of monitoring/data interpretation and cybersecurity baseline literacy.
- Sustainability expectations increasingly include **lifecycle readiness** (waste/materials handling, resource efficiency, and documentation).
- Training demand is shifting toward **modular**, **work-compatible formats**.

What EU-level inputs add (cross-border enabling conditions):

- Recognition and portability depend on **quality assurance**, **assessment evidence**, **and employer endorsement**, and benefit from clearer cross-border signalling (stackability/metadata/standard language of outcomes).
- A practical "core + local adaptation" logic is suggested for curricula (common baseline + contextual tailoring), which aligns with the need to scale microcredential uptake across EU contexts.

### Triangulation with survey and desk research (how the evidence fits together)

The EU-level stakeholder lens further reinforces the same convergence signals identified in the country evidence.

**Alignment with the survey results (Q6–Q15)**
The qualitative convergence patterns reinforce the quantitative "need" profile:

- **Digital**: operational competence (monitoring/data/cyber) and learning agility (Q6) align with country narratives emphasizing data-driven O&M and practical digitalization.
- **Green**: efficiency + compliance anchoring (Q7) matches repeated qualitative emphasis on safety/compliance, environmental practice, and lifecycle readiness.
- **Soft**: adaptability/problem-solving dominance (Q9) aligns with country-level stress on autonomy, troubleshooting, teamwork, and learning-to-learn.
- **Technical**: system integration, monitoring/control, grid interface, and diagnostics (Q10) match the most repeated country-level bottlenecks; emerging skills (Q11) mirror qualitative mentions of AI/predictive maintenance, storage, smart grids, interoperability, and cyber.
- **microcredentials**: the qualitative insistence on QA/recognition mechanisms aligns directly with Q12–Q13 (awareness gap + recognition bottleneck) and with training format preferences (Q14–Q15).

### Alignment with desk research

Country evidence supports common EU-wide desk research messages: the RES workforce must be upskilled for **digitalized infrastructure, grid integration**, **storage**, and **sustainability/lifecycle requirements**, and VET/training systems must respond with modular, quality-assured, labor-market-readable provision.

### Implications for cross-cutting insights and recommendations

The cross-country synthesis suggests that recommendations should prioritize:

1. **Job-ready competence** (hands-on diagnostics, safe work, monitoring/control, grid interface)
2. **Operational digitalization** (data interpretation, remote monitoring, cybersecurity) as baseline
3. **Lifecycle readiness** (circular economy practices + sustainability documentation) alongside compliance
4. **Hybrid training design** (technical + digital + green + soft skills embedded in realistic scenarios)
5. **microcredential credibility conditions** (clear outcomes, assessment evidence, employer endorsement, metadata/portability, and stackability into qualification pathways)

# 05.

## Recommendations and Conclusion

# 5. Recommendations and Conclusion

## 5.1 Recommendation logic

Recommendations are designed to be implementable within MiCRET and directly usable for the microcredential work. They are grounded in convergent evidence from:

- survey priorities on digital, green, soft, and technical gaps; recurring open-ended themes on today's gaps and the 3–5 year frontier;
- and qualitative stakeholder constraints (feasibility, recognition, training capacity, workplace realities).

## 5.2 Core recommendations

**R1. Build microcredentials around job-critical operational capability, not "generic theory."**

**Why**: Across evidence, the strongest needs relate to **applied competence**-diagnosing faults, interpreting performance data, operating monitoring/control systems, and working safely in real conditions.

**What to implement:**

- Define learning outcomes as **observable tasks** (e.g., interpret alarms and decide actions, commission monitoring, and document interventions).
- Require **practical assessment evidence** (workplace task, lab simulation, scenario test), not only quizzes.
- Use short modules that can stack into a pathway (see R6).

**R2. Prioritize a "Data-enabled O&M" bundle as a flagship (Digital pillar)**

**Why**: Digital needs are repeatedly framed as **operational**: data interpretation, SCADA/monitoring, IoT/sensors, and cybersecurity awareness in field contexts.

**What to implement:**

- SCADA/EMS fundamentals for technicians (alarms, KPIs, remote diagnostics)
- IoT/sensors & condition monitoring basics
- Performance data interpretation and reporting
- Cybersecurity baseline for connected energy assets (OT awareness)

**R3. Deliver a dedicated "System integration & hybrid systems" bundle (Technical, Digital, Green interface)**

**Why**: A key gap and future frontier is moving from component installation to **integrated system performance** (storage integration, smart grids/microgrids, interoperability, commissioning/optimization).

**What to implement:**

- Commissioning & optimisation of hybrid assets (PV, storage, EV charging, heat pumps and PV, etc)
- Interoperability basics (multi-vendor integration, communication/handovers, configuration logic)
- "Systems thinking for technicians" focused on interfaces and dependencies (not abstract theory)

**R4. Treat safety and compliance as a high-visibility spine across modules (Green and Technical)**

**Why**: Green competence needs are anchored in efficiency optimization and regulatory/safety compliance, while technical gaps repeatedly include HV/MV/DC safety, grid interface risks, and safe procedures.

**What to implement:**

- Embed safety outcomes into every relevant microcredential (LOTO, HV/MV/DC risk controls, and working at height/ offshore where applicable).
- Include **incident/scenario-based assessment** (what to do when monitoring flags an abnormal condition, how to isolate, and what to document).
- Keep an "update mechanism" for regulatory content (short refresh micro-units).

**R5. Include lifecycle readiness as the practical face of "green skills" (Green pillar)**

**Why**: Beyond compliance, evidence points to the rising importance of circular economy practices, waste/recycling, and sustainability documentation literacy (e.g., LCA/ESG awareness) as assets scale and age.

**What to implement:**

- Technician-facing "circularity in fieldwork" (waste handling, dismantling, material traceability basics)
- Basic sustainability documentation literacy (what is recorded, why it matters, how technicians contribute)
- Link to real tasks: decommissioning steps, maintenance logs, component handling decisions

**R6. Make microcredentials stackable and employer-readable from day one**
**(Recognition + portability)**

**Why**: Survey signals show usefulness can be high even when recognition is weaker; uptake depends on clear signalling, credible assessment, and employer engagement.

**What to implement:**

- Use a consistent microcredential "passport" template: outcomes, workload, EQF/competence mapping, assessment method, and evidence generated.
- Create stacking rules (e.g., 3–4 microcredentials → certificate pathway).
- Build an employer validation loop (pilot endorsement; feedback on readability and job relevance).

**R7. Align delivery with how technicians actually learn: work-based and blended**

**Why**: Training preferences and improvement suggestions consistently prioritise work-based learning and blended approaches, with strong demand for hands-on practice and integrated digital tooling.

**What to implement:**

- Use a "**theory online → practice in lab/site**" structure.
- Where high-risk tasks exist, add simulation/VR where feasible (as preparation, not replacement).
- Include trainer support packages (guides, scenarios, and assessment rubrics) to reduce delivery variability.

| Recommendation | Skill Pillar(s) | What to implement (concrete actions) |
|---|---|---|
| **R1. Job-critical, task-based competence** | Technical + Digital + Soft | Define microcredentials as **observable workplace tasks** (commissioning, diagnostics, reporting); require **practical assessment evidence** (lab/site scenario, logbook, troubleshooting report). |
| **R2. Data-enabled O&M bundle** | Digital + Technical | Create a "Data-enabled O&M" bundle: **monitoring/ SCADA/EMS basics**, KPI/dashboard interpretation, remote diagnostics, sensor/condition monitoring, OT/ cyber awareness. |
| **R3. System integration & hybrid systems bundle** | Technical + Digital + Green | Modules on **hybrid systems integration** (PV+storage+EV; heat pumps+PV), commissioning/optimization, interoperability basics, and grid-interface basics for technicians. |
| **R4. Safety + compliance spine** | Green + Technical + Soft | Embed **safety outcomes** across modules:<br>• HV/MV/DC, LOTO, working-at-height/offshore (where relevant), emergency response<br>• Assess via scenarios ("What do you do when an alarm/ incident occurs?"). |
| **R5. Lifecycle readiness (circularity + documentation)** | Green + Digital | • Short modules on **circular practices** (waste handling, dismantling, materials traceability)<br>• Basic LCA/ESG awareness for technicians, sustainability documentation ("what technicians must record and why"). |
| **R6. Employer-readable, stackable credentials** | System/workforce + all pillars | • Adopt a microcredential "passport": outcomes, workload, assessment evidence, mapping<br>• Define **stacking rules** (f.e 3–4 credentials to lead certificate pathway)<br>• Employer validation loop. |
| **R7. Delivery model aligned to technician reality** | System/workforce + all pillars | • Use **blended + work-based learning**: online theory + lab/ site practice; use simulation/VR where high-risk<br>• Provide trainer packs (scenarios, rubrics) to reduce variability. |

## 5.3 Conclusions

This D2.1 analysis confirms a consistent picture across desk research, the EU-level survey, and country/EU qualitative inputs: the Renewable Energy Technician profile is evolving toward **digitized**, **integrated**, **performance-driven work contexts**, where competence is defined less by isolated "component installation" and more by the ability to **operate**, **maintain**, **and optimize connected systems safely and reliably**.

Across the four skill pillars, the strongest convergent signal is the need for **hybrid**, **job-ready competence** at the intersection of **Technical + Digital + Green** requirements-supported by transversal skills that enable safe decision-making and continuous adaptation. Digital needs are primarily framed as **operational capability** (monitoring/control systems, data interpretation, sensor-enabled maintenance, and cybersecurity awareness), while green competence is anchored in **efficiency and compliance** and is increasingly complemented by **lifecycle readiness** (resource efficiency, circular practices, and sustainability-related documentation awareness). In parallel, open-ended inputs underline that the "frontier" skills for the next 3–5 years-AI-enabled monitoring, smart grids/microgrids, storage integration, interoperability, and strengthened cybersecurity-are already beginning to shape expectations for technicians and adjacent roles.

The report therefore supports a microcredential approach that is **modular**, **stackable**, **and assessment-dr**iven, designed around observable workplace tasks (commissioning, troubleshooting, safe work procedures, and performance optimization) rather than broad theoretical coverage. However, D2.1 also highlights a critical implementation condition: microcredentials will only translate into labor-market value if they are **employer-readable** (clear outcomes, credible assessment evidence, consistent metadata) and embedded in delivery models that reflect technician realities-namely **work-based and blended learning**, with strong practical components and clear progression routes.

In the next phase of MiCRET, the priority is to translate these evidence-backed competence clusters into a **small set of coherent microcredential bundles** aligned to the four pillars, accompanied by a common specification template (learning outcomes, assessment, evidence generated, portability/stackability) and a light governance mechanism for keeping content updated as technology and regulation evolve.

# 06.

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