RESkill 4NetZero
Boosting Green Energy Careers

Ref. Ares(2025)10431670 - 28/11/2025

ReSkill4NetZero
WP2 D2.2 RES Skills Strategy

30/11/2025

Co-funded by the European Union

Funded by the European Union under Grant Agreement n°101186624. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor the granting authority can be held responsible for them.

REskill 4NetZero
Boosting Green Energy Careers

Project	ReSkill4NetZero
EC-Grant Agreement	101186624
Program	ERASMUS +
Client	European Education and Culture Executive Agency (EACEA)
Start of the Project	01.12.2024
Duration	48 months
Document Title	**ReSkill4NetZero Communications Strategy & Tools**
Work Package	WP2: Skills Intelligence, Needs Analysis & Renewable Energy Skills Strategy for Europe
Deliverable	D2.2: RES Skills Strategy for Europe
Lead Beneficiary	Abodoo
Project Coordinator	KIC InnoEnergy
Dissemination Level	**PU — Public,**
Authors	Elisa Forestan-Barnes (abodoo) and Consortium partners
Reviewers	ReSkills4NetZero Consortium partners Industry advisory board Members Lucia Grilli (Schuman Associates) GCP and Europe On Members
Description	Development and launch of an innovative renewable energy skills strategy
Status	**Final**
Delivery Date	30.11.2025
Due Date:	30.11.2025
Approval Date:	30.11.2025

Revision History

Version	Date	Modified my	Comments
1	**15.10.2025**	**abodoo**	Initial Draft (consortium partners)
2	**05.11.2025**	**abodoo**	Internal Review (consortium and IAB members)
3	**13.11.2025**	**Shuman Associates**	External Review (Lucia Grilli)
4	**19.11.2025**	**GCP and Europe On**	Feedback received during presentation in Brussels
5	**25.11.2025**	**GCP and Consortium partners**	Final Review
6	**30.11.2025**	**InnoEnergy**	Final Version & Upload

Co-funded by the European Union

Legal Disclaimer:

Funded by the European Union under Grant Agreement n°101186624. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor the granting authority can be held responsible for them.

TABLE OF CONTENT

List of Tables

RESkill 4NetZero
Boosting Green Energy Careers

GLOSSARY

AI	Artificial Intelligence
BMS	Battery Management System
CAD	Computer-Aided Design
DER	Distributed Energy Resources
DCE	Communication, Dissemination and Exploitation
DMP	Data Management Plan
ESCO	European Skills, Competences, Qualifications and Occupations
EU	European Union
HMI	Human-Machine Interface
HVAC	Heating, Ventilation, and Air Conditioning
LLM	Large Language Model
LCA	Life Cycle Assessment
O&M	Operation and Maintenance
OSH	Occupational Safety and Health
PLC	Programmable Logic Controller
PV	Photovoltaic
QAP	Quality Assurance Plan
RE	Renewable Energy
RES	Renewable Energy Sources
RESP	Renewable Energy Skills Partnership
SCADA	Supervisory Control and Data Acquisition
SME	Small and Medium-sized Enterprise
VET	Vocational Education and Training
WP	Work Package

Executive Summary & Structure of the document

The renewable energy sector is at the heart of Europe's transition to climate neutrality by 2050. Achieving the ambitious targets set by the **European Green Deal**, **REPowerEU Plan**, and **Net-Zero Industry Act** requires not only technological and financial investment, but also a skilled and adaptable workforce. Without sufficient numbers of qualified technicians, engineers, and specialists, deployment will stall, costs will rise, and Europe risks losing its competitive edge in global clean energy markets.

This **Renewable Energy Skills Strategy** provides a comprehensive roadmap for aligning Europe's education and training systems with the rapidly evolving needs of the renewable energy industry. Developed under the **ReSkill4NetZero project (Erasmus+)**, it is based on extensive analysis of occupational profiles, skills demand, and systemic challenges across renewable energy subsectors, as well as consultation with stakeholders across Europe.

Key Findings

- **Acute shortages** of technicians and skilled workers (e.g., solar PV installers, wind turbine technicians, heat pump specialists, electricians).
- **High demand** for cross-disciplinary engineers able to integrate digital, regulatory, and technical knowledge.
- **Emerging roles** in digitalisation, cybersecurity, AI, and circular economy with little training provision available.
- **Fragmented education and training systems**, with limited cross-border recognition of qualifications.
- **Lack of trainers and up-to-date equipment**, weakening the quality of training delivery.
- **Low attractiveness of careers** in technical and vocational fields, coupled with gender imbalance and underrepresentation of young people.
- **Regional differences**: Offshore wind in Northern Europe, solar PV in Southern Europe, hydrogen and geothermal in Central and Eastern Europe, and battery storage needs across the EU.

Recommendations

The strategy proposes a unified European approach to renewable energy skills development, with seven priority actions:

1. **European Renewable Energy Skills Alliance**: Establish a permanent platform under the Pact for Skills to coordinate curricula, standards, and workforce planning across the EU.
2. **Recognised and Portable Qualifications**: Align renewable certifications with the EQF and ESCO; create an EU-wide RES Skills Quality Mark and digital skills passports via Europass.
3. **Modernise Education and Training Systems**: Scale modular learning and micro-credentials; expand apprenticeships and industry–education partnerships; improve trainer mobility and equipment.
4. **Prioritise Digital and Transversal Skills**: Integrate AI, cybersecurity, and SCADA with project management, regulatory literacy, and systems thinking across all programmes.
5. **Enhance Career Awareness and Youth Engagement**: EU-wide campaigns, school outreach, role model programmes, and targeted actions for women and underrepresented groups.
6. **Support Just Transition and Regional Needs**: Tailor retraining for fossil fuel workers; establish regional training hubs; improve mobility across borders.
7. **Secure Sustainable Funding and Policy Alignment**: Mobilise EU and national funds, incentivise SME participation, and align skills strategies with National Energy and Climate Plans.

Conclusion

The renewable energy transition is a **skills transition.** By investing in education, recognition, and career pathways, Europe can ensure its workforce is prepared for the challenges ahead, accelerate the deployment of renewables, strengthen industrial competitiveness, and create inclusive opportunities across regions. Skills are the currency of the clean energy economy — this strategy provides the framework for making them accessible, portable, and future-proof.

Structure of the document

1. Introduction

The strategy opens by setting the context: Europe's ambitious climate and energy targets and the critical role of renewable energy in achieving them. It highlights why skills are central to the net-zero transition and explains the purpose of this strategy — to provide a roadmap that bridges the gap between labour market needs and training systems.

2. Skills Needs in the Renewable Energy Sector

This section provides an overview of the skills and occupational profiles most in demand across different renewable subsectors. It identifies commonalities — such as the acute shortage of technicians — while also recognising regional variations and new cross-cutting roles driven by digitalisation and system integration.

3. Challenges and Gaps

The analysis then turns to the barriers holding back workforce readiness: skills mismatches, lack of trainers and modern equipment, limited recognition of qualifications across Member States, and the low attractiveness of careers in technical fields. Issues of inclusivity, gender imbalance, and regional disparities are also explored.

4. Strategic Recommendations

The core of the strategy outlines seven areas of action to close the skills gap and build a coherent European response. These include creating a European Renewable Energy Skills Alliance, establishing recognised and portable qualifications, modernising training systems, embedding digital and transversal skills, improving career awareness, supporting just transition pathways, and securing sustainable funding.

5. Conclusions

The document closes by synthesising the findings and making the case for a unified European Skills Strategy. It emphasises that meeting Europe's 2030 and 2050 goals will depend not only on technology and investment but also on building a workforce that is skilled, mobile, and future proof.

1. Introduction

The European Union has set ambitious targets for achieving climate neutrality by 2050, with renewable energy playing a central role in meeting these objectives. The **European Green Deal** (European Commission, 2019), the **REPowerEU Plan** (European Commission, 2022), and the **Net-Zero Industry Act** (European Commission, 2023) all underline the need for rapid expansion of clean energy capacity across Member States. However, the success of this transition will depend not only on technological innovation and investment but also on the availability of a highly skilled workforce capable of designing, installing, operating, and maintaining renewable energy systems.

Labour market data and stakeholder consultations show that Europe is facing a **dual challenge**: scaling up renewable deployment at unprecedented speed while addressing persistent skills shortages, mismatches, and training gaps. Current education and training systems are struggling to keep pace with industry needs (ReSkill4NetZero, 2025a), leading to severe bottlenecks, particularly in technical and vocational roles. At the same time, new types of interdisciplinary expertise are required as digitalisation, system integration, and circular economy principles reshape the sector (ReSkill4NetZero, 2025a).

This Skills Strategy is developed under the **ReSkill4NetZero project** (ReSkill4NetZero, 2025b), funded by the European Union through Erasmus+, to provide a coherent, evidence-based roadmap for building a future-proof workforce. It builds on the findings of **Work Package 2 (Occupational Profiles and Needs Analysis)** and extensive stakeholder engagement, including surveys, interviews, and workshops across the renewable energy value chain. Its aim is to identify the competencies most in demand, highlight the barriers that currently hinder workforce readiness, and propose practical and policy-oriented recommendations to bridge the gap between training supply and labour market demand.

1.1. Purpose and Scope of the Strategy

The RES Skills Strategy is not limited to a single subsector but adopts a **holistic and cross-cutting approach**. It addresses both immediate skills needs and longer-term system challenges, proposing measures to:

- Align education and training provision with fast-evolving labour market demands.
- Foster recognition and portability of skills across Member States to enhance worker mobility, building on frameworks such as the **European Qualifications Framework (EQF)** (European Parliament and Council, 2008), **ESCO** (European Commission, 2017), and **Europass Digital Credentials** (European Commission, 2023). The strategy also considered the European Sustainability Competence Framework (GreenComp), which defines key sustainability competences for lifelong learning, and the EU Taxonomy of sustainable activities, which defines which economic activities are considered environmentally sustainable (European Commission, 2020, 2022).
- Promote career attractiveness, diversity, and inclusivity in the renewable energy sector.
- Equip the workforce with transversal and digital skills alongside technical expertise.
- Support a just transition for workers and regions dependent on fossil fuel industries, in line with the **European Skills Agenda** (European Commission, 2020).

By connecting national efforts with EU policy frameworks, the strategy lays the foundation for a unified European approach.

1.2. Renewable Energy Subsectors and Implications for Skills

The renewable energy sector is not a single, uniform industry but rather a diverse ecosystem of subsectors, each with its own technologies, occupational structures, and training requirements. Key subsectors include:

- **Wind energy** (onshore and offshore) – with roles such as turbine technicians, offshore project managers, and health and safety specialists.
- **Solar energy** (PV and thermal) – requiring skills in installation, electrical and hydraulic

integration, thermal energy storage, integration with existing heating systems, and digital monitoring systems.

- **Bioenergy (solid and gaseous) –** generating demand for gas technicians (including biogas plant operators), biological and mechanical engineers, and compliance officers with specialised knowledge of safety and regulation.
- **Hydrogen –** creating demand for chemical engineers, gas safety specialists, and compliance officers with advanced regulatory expertise.
- **Geothermal, solar thermal and heat pumps** – relying on mechanical and HVAC technicians, drillers, and system integration experts.
- **Energy storage and batteries** – creating jobs for industrial engineers, quality assurance staff, and operatives skilled in automation and advanced manufacturing.
- **Grid and system integration** – driving demand for SCADA operators, data analysts, and cybersecurity specialists to ensure stable, smart, and resilient energy systems.

Because of this diversity, **job titles, responsibilities, and required skill sets vary considerably between subsectors**. For instance, an "installation technician" in solar will have different technical training compared to a "maintenance technician" in offshore wind. Similarly, engineers in hydrogen projects must master gas safety and regulatory compliance, while battery engineers focus on industrial process optimisation and automation.

Despite these differences, the sector also relies on a **core set of transferable skills**. These include:

- **Technical foundations** (electrical and mechanical engineering, installation, troubleshooting).
- **Digital capabilities** (data analysis, programming, SCADA systems, digital twins, automation).
- **Transversal competencies** (project management, stakeholder communication, regulatory literacy such as permitting processes, safety codes, and compliance frameworks, sustainability awareness).

This Skills Strategy is therefore designed to focus on **general and cross-cutting training** that equips workers with competencies applicable across multiple subsectors. By building a strong foundation of technical, digital, and transversal skills, professionals can move more easily between subsectors, adapt to emerging technologies, and contribute flexibly to the energy transition.

The approach recognises that while **specialised training will remain essential** for certain niche technologies or roles, a skills strategy ensuring professionals have full skillsets with additional **modular, transferable competencies** provides the greatest resilience. The latter allow for faster reskilling and upskilling, supports worker mobility across subsectors, and ensures that Europe's renewable energy workforce is future-proof and adaptable to evolving industry needs.

1.3. Linking Skills to the Net-Zero Transition

The renewable energy workforce is both a driver and an enabler of Europe's decarbonisation. Without sufficient numbers of qualified technicians, engineers, planners, and operators, deployment timelines will slip, project costs will rise, and the EU risks falling short of its **2030 renewable energy targets** (European Commission, 2019; European Commission, 2022). Conversely, with the right skills in place, Europe can not only accelerate the energy transition but also capture industrial leadership in technologies such as offshore wind, solar PV manufacturing, batteries, and hydrogen (European Commission, 2023). Appropriate skills policies also can contribute to maintaining Europe's strong manufacturing base in technologies such as solar thermal and heat pumps (CETO Reports, 2024).

This Skills Strategy therefore represents more than a workforce development plan: it is a **pillar of Europe's competitiveness, climate resilience, and social cohesion**. It recognises skills as the currency of the clean energy economy and seeks to ensure that every region, sector, and citizen can contribute to — and benefit from — the green transition.

2. Understanding Jobs and Skills Demand in the Renewable Energy Sector

2.1. Introduction

The transition to a climate-neutral economy is accelerating across Europe, driven by urgent decarbonisation goals and an expanding renewable energy industry. As this transformation unfolds, a new landscape of occupations and skillsets is emerging—placing unprecedented pressure on labour markets, education systems, and training provision.

This chapter outlines the key findings of the RESkill4NetZero Work Package 2 (WP2), which identifies the most critical roles and skills required across the renewable energy value chain. Drawing on data from surveys, job advertisements, expert interviews, and industry reports, it highlights the structural skill gaps and labour shortages shaping the sector. Table 1 below provides a summary of the data collection methods and the data sources used for the skills analysis report.

Table 1: Data Sources used in D2.1

	Data collection method	Data Source	Number
1	Secondary data	Industry reports	36
2		Job advertisements	70,000 (42,037 after data cleaning)
3	Primary data	Workforce survey (2023)	154 respondents (21 countries)
4		Workforce survey (2025)	34 respondents (14 countries)
5		Qualitative Interviews	9 (industry experts)

(For a more detailed breakdown of data please see D2.1 report)

The findings have been organised into key occupational categories to provide a strategic overview of where the most urgent gaps exist, and what kinds of skills are needed to meet future workforce demands.

An overview of the methodology used to carry out the analysis for both jobs and skills in demand is provided in the next section. An overview of all methods and data used in the analysis is provided in Annexe 1.

2.2. Methodology for Occupational Profiling and Skills Classification

The identification and validation of occupational profiles within RESkill4NetZero are based on the multi-source analytical methodology established in Deliverable D2.1 (Occupational Profiles and Needs Analysis). This methodology combines qualitative and quantitative evidence to ensure that the occupational profiles included in the RES Skills Strategy reflect real labour-market demand, future skills needs, and sector-specific dynamics[1].

2.2.1 Multi-Source Evidence Base

The classification of occupational profiles is grounded in five complementary data sources:

- **Industry and strategic reports** (36 documents): analysed using an AI-assisted pipeline to extract roles, skill needs, and technology references at scale.
- **Job market analysis**: 70,000 job advertisements scraped and processed (42,073 after cleaning), providing granular signals on role frequency, emerging job titles, and required skills.
- **Two pan-European surveys** (2023 and 2025): providing quantitative measures of recruitment challenges, skill shortages, and organisational developments.
- **Expert interviews** (9 interviews): offering qualitative insights on emergent roles, sector

[1] The full methodology is available in D2.1: Skills need analysis.

bottlenecks, and competency expectations.

- **Training offer mapping** (89 courses): enabling assessment of current provision and its alignment to workforce demand.

These data sources were processed through structured extraction, semantic analysis, and cross-validation to ensure that occupational profiles are both empirically grounded and future-oriented.

2.2.2 Classification Approach

The classification of occupational profiles followed two steps:

1. **Validation of pre-defined profiles** against multiple evidence sources:
    a. Profiles were considered validated when they appeared across surveys, job ads, industry reports, and interviews.
    b. Example: Renewable Energy Technicians were confirmed as the most frequently demanded role across all sources
2. **Identification of additional or emerging profiles** not originally listed:
    a. Roles such as Project Managers, Offshore Marine Crew, Welders, Battery Cell/Pack Assemblers, Cybersecurity Specialists, Software Developers, and Retrofitting Experts emerged through job-market evidence and expert interviews.
    b. These roles were grouped into logical clusters (technical, digital, managerial) and incorporated into the extended framework.

Each profile was mapped to relevant tasks, skill categories (technical, digital, transversal), and training needs.

2.2.3. Methodology for Classifying Skills in Demand

Skills Extraction and Standardisation

Skills were identified using a combination of:

- Automated skill extraction from reports and job ads using large language models
- Survey-derived skills gaps (e.g., data analysis, HVAC knowledge, hydrogen safety, project management)
- Interview-based thematic coding (e.g., digitalisation, circular economy, SCADA/PLC integration)

To ensure consistency, all extracted skills were mapped to ESCO skill concepts using:

- Fuzzy matching
- Sentence-transformer semantic similarity
- Cross-encoder models for final validation

This process enabled harmonisation of diverse terms (e.g., “solar installer”, “PV fitter”, “PV technician”) under common ESCO concepts.

Linking Skills to Occupational Profiles

Skills were associated with occupational profiles through a systematic cross-mapping:

- Skills appearing frequently in job advertisements or survey responses were matched to the roles that referenced them.
- ESCO’s existing taxonomy facilitated the linking of broad skill clusters to specific occupations.
- Profiles were also grouped under thematic skills areas emerging from the analysis, including:
    - Technical skills
    - Digital skills
    - Transversal skills

- Regulatory and safety competencies
- Emerging/future skills (AI, automation, circularity)

This allowed the identification of the most frequently demanded skills per occupational profile, for example:

- **Renewable Energy Technicians**: electrical wiring, mechanical assembly, system integration, fault detection, health & safety protocols
- **Energy Engineers**: system design, digital twins, circularity, SCADA, project planning
- **Industrial Engineers**: process automation, Industry 4.0, quality assurance
- **Electricians**: low/high voltage safety, PV and heat pump integration, PLC/SCADA skills
- **Power Plant Operators**: PLC programming, SCADA monitoring, diagnostics

(Examples supported by evidence across job boards, reports, and interviews in D2.1.)

These skill–profile linkages form the analytical foundation for the Skills Strategy recommendations on training design, modular curricula, and qualification frameworks. A table providing an overview of the most frequently demanded skills per occupational profile and a diagram addressing thematic grouping of occupational profile in the RES are included in Annexe 2.

2.2.4. Using ESCO in the RES Skills Strategy: Value and Limitations

Role of ESCO

ESCO (European Skills, Competences, Qualifications and Occupations) (European Commission), was used as the reference taxonomy to ensure:

- Consistency in occupational descriptions across the consortium
- Alignment with EU frameworks for transparency, mobility, and comparability
- A shared skills vocabulary linking training supply with labour-market demand

The project mapped all 13 predefined occupational profiles to ESCO occupations and matched extracted skills to ESCO skill concepts, ensuring compatibility with EQF-aligned curricula and future Europass Digital Credentials.

Strengths of ESCO for this project

- **EU-wide standardisation** of job titles and skills across Member States
- **Supports labour mobility** by making occupations comparable
- **Multilingual taxonomy**, enabling cross-border alignment
- **Structured hierarchy** of skills and knowledge, useful for training design
- **Easily integrated** with digital skills passports and micro-credentials

These advantages make ESCO a strong foundation for a unified Skills Strategy.

Limitations of ESCO in the Context of Renewable Energy

While ESCO provides valuable structure, several limitations were identified during the analysis:

1. Limited granularity for emerging green roles

ESCO does not yet fully cover rapidly evolving occupations such as:

- Hydrogen technicians
- Battery cell/pack assembly specialists
- SCADA programmers
- Digitalisation specialists in renewable plants
- AI/modelling specialists
- Retrofitting experts

These needed to be approximated using combinations of existing ESCO roles.

2. Hybrid and cross-sector roles are underrepresented

The renewable energy transition increasingly demands roles combining:

- Technical + digital + regulatory expertise
- Engineering + project management
- Sustainability + industrial process optimisation

ESCO currently separates these domains more rigidly.

3. Variation in terminology across job market

The identification and validation of occupational profiles within RESkill4NetZero are based on the multi-source analytical methodology established in Deliverable D2.1 (Occupational Profiles and Needs Analysis). This methodology combines qualitative and quantitative evidence to ensure that the occupational profiles included in the RES Skills Strategy reflect real labour-market demand, future skills needs, and sector-specific dynamics.

2.2. Occupational Profiles in demand

A. Technicians and Skilled Workers (Blue/Grey Collar)

These roles represent the operational core of the renewable energy sector. They are often the first to face bottlenecks as deployment scales, and are critical to ensuring quality, safety, and efficiency in technology rollouts.

1. Renewable Energy Technicians (Wind, Solar, Geothermal, Heat Pumps)

- Tasks: Installation, commissioning, systems integration, troubleshooting, repair and maintenance of RE systems.
- Skills needed: Mechanical installation, environmental-safe drilling, HVAC integration, electrical wiring, welding, RE system basic knowledge, refrigerant handling and leak prevention, system integration, troubleshooting, diagnostics, safety standards, and customer communication.
- Gap: Severe; significant shortages, particularly for heat pump and solar installers. EU-wide scarcity of skilled technicians in the renewables sector.
- Needs supervision from qualified professional

2. Gas Technicians (Biogas and Hydrogen)

- Tasks: Install, maintain and monitor biogas and hydrogen gas systems, hydrogen pipeline integration, injection control, operational efficiency, safety and compliance with environmental standards.

- Skills needed: Gas safety, gas system installation, digital monitoring systems, monitoring equipment, environmental regulation knowledge and compliance, maintenance, diagnostics, leak detection, system testing.
- Gap: High; growing due to hydrogen scale-up and biogas expansion.

3. HVAC and Refrigeration Technicians

- Tasks: Install, maintain, and repair energy-efficient heating and cooling systems.
- Skills needed: System integration, HVAC installation, refrigeration systems, energy-efficiency practices, fluid dynamics, refrigerant safety, standards, and compliance, maintenance and diagnostics, solar thermal system design and sizing, thermal energy storage integration.
- Gap: Medium to high; rising need in renewables and energy-efficient systems, especially in countries focusing on energy retrofits.

4. Electricians (Domestic and Industrial)

- Tasks: Installing, maintaining, and repairing residential/industrial electrical installations, DER technologies, integration of DERs, advising consumers on how to electrify.
- Skills needed: Electrical wiring, DER technologies and systems knowledge, system integration, PLC programming, SCADA operation, human-machine interfaces (HMI) operation, low/high voltage safety protocols, troubleshooting and diagnostics, PV mounting, PV connection, heat pump installation, battery storage installation, safety,
- Gap: Severe shortage; especially in residential and solar PV installations but also rising demand for industrial electricians in energy transition sectors.

B. Engineering Roles (White Collar)

Engineering functions are pivotal in designing, optimising, and integrating renewable energy systems. However, increasing system complexity requires a broader mix of technical, digital, and strategic skills.

1. Energy Engineers

- Tasks: Research, design, and implement renewable projects and hybrid systems, lifecycle analysis and circularity, energy modelling and systemic integration.

- Skills needed: Engineering foundations, digital twins, circularity, digitalisation and smart grid knowledge, SCADA systems, project planning, systemic/holistic thinking, energy efficiency, sustainability strategy.

- Gap: High; Persistent and widening, especially for roles requiring cross-domain knowledge and digital skills, and strong demand for engineers bridging technical and managerial expertise.

2. Renewable Energy Consultants

- Tasks: Project planning and RE plant design, feasibility studies (site selection, system orientation), permitting processes, stakeholder management.

- Skills needed: Regulatory knowledge, international project coordination, project feasibility analysis, RE system design, heating and cooling system integration, permitting and compliance, stakeholder communication.

- Gap: Medium to high; demand is growing as energy systems become more complex and there is limited supply of engineers with cross-technology expertise and knowledge, especially for hybrid systems.

3. Industrial Engineers

- Tasks: Design of industrial processes, integration of Industry 4.0 and automation, optimisation of RE technology manufacturing and efficiency.

- Skills needed: Industry 4.0 tools, industrial systems design, process optimisation, production line automation, quality assurance, robotics, data-driven decision making.
- Gap: Medium; especially in countries scaling up solar or battery production.

C. Factory and Manufacturing Operatives

This group includes blue-collar roles essential for assembling, testing, and maintaining RE hardware.

Factory Operatives / Maintenance Staff

- Tasks: Production and assembly of clean tech components, operation and maintenance of machinery in clean-tech manufacturing, quality checks, support of production efficiency.
- Skills needed: Quality control, machine operations, logistics coordination, maintenance procedures, safety standards and compliance, troubleshooting, process monitoring, basic digital literacy.
- Gap: Emerging; especially in solar PV and battery cell/pack assembly sectors.

D. Operational and Systems Roles

These roles ensure renewable energy systems operate effectively, safely, and efficiently over time.

1. Power Plant Operators

- Tasks: Monitor, operate, and maintain RE plants (solar, wind, biogas), program and monitor sensors, PLCs, SCADA systems.
- Skills needed: SCADA systems, PLC programming, sensor programming, real-time monitoring, diagnostics, fault detection, maintenance practices, safety procedures.
- Gap: Moderate; complex plants require multi-skilled operators.

2. Health and Safety Professionals

- Tasks: Ensure workplace safety in RE installations, oversee safety protocols across complex RE environments, manage safety permits.
- Skills needed: Sector-specific safety protocols and regulations, refrigerant handling, hazard detection, risk assessment, compliance, emergency protocols, site audits.
- Gap: High; especially for wind and heat pump installations.

E. Strategic, Planning, and Support Roles

Though often overlooked, these roles are critical for enabling policy alignment, regulatory compliance, and project implementation.

1. Planners (Permits, Regulation, Urban Planning)

- Tasks: Land use planning, energy and urban planning, permitting and licensing, regulatory processes, community engagement.
- Skills needed: Renewable energy policy knowledge, RES technology understanding, urban and regional planning, ESCO knowledge, digital mapping, permitting and regulatory frameworks, project management, stakeholder engagement.
- Gap: Growing; delays in project approvals due to lack of skilled planners trained specifically in renewable energy integration.

2. Project Managers

- Tasks: Oversee RE project delivery across lifecycle, coordinate stakeholders, manage budgets, schedules, compliance and reporting, risk assessment and mitigation.
- Skills needed: Project management methodologies, budgeting, multi-stakeholder coordination and engagement, risk management, RE technology knowledge, regulatory frameworks.
- Gap: High; particularly for offshore wind and hydrogen projects. Insufficient cross-sector

project managers available.

F. Emerging Cross-Sector Roles

- Examples: SCADA Programmers, AI Specialists, Retrofitting Experts, Cybersecurity specialists, Energy data analysts.

- Skills needed: Digitalisation, data analytics, software engineering, circular economy practices, industrial automation, machine learning, AI, programming, cybersecurity frameworks, systems thinking.
- Gap: Growing rapidly; few formal training paths exist yet. Demand driven by accelerating digitalisation of RE plants, EU climate targets and policies, rising cybersecurity risks.

2.3. Skills in demand

The sector shows strong demand for a combination of:

1. Technical Skills

- Electrical and mechanical engineering
- Energy system design and integration
- Fluid dynamics, thermodynamics
- Installation and maintenance protocols
- Equipment maintenance
- Troubleshooting
- Installation and maintenance of RE systems
- Energy systems knowledge
- Process engineering
- Process optimisation
- Grid integration
- Quality control

2. Digital Skills

- Programming (Python, PLCs)
- Data analysis
- SCADA & industrial control systems
- CAD and simulation tools
- Application of artificial intelligence
- Automation systems

3. Transversal Skills

- Project management
- Interdisciplinary teamwork
- Communication and stakeholder engagement
- Regulatory literacy and standards compliance
- System-level thinking
- Sustainability compliance

2.4. Current Education and Training Programmes Offer in the Renewable Energy Sector

2.4.1. Overview of current training programmes offering

A comprehensive mapping exercise identified **89 renewable energy training courses across Europe**, covering a broad mix of technologies and skills[2]. These courses span both technical and non-technical areas and vary significantly in their distribution across subsectors and countries.

By subsector:

- **Battery Storage** dominates provision with 37 courses, reflecting its central role in renewable

[2] These list of courses does not cover all the available courses in the sector but reflects the education and training available at the time the data were collected. The list of courses will be updated in the next phase of the project.

energy systems.

- **Photovoltaic (PV) Solar** (16 courses) and **Solar Energy** (10 courses) also feature prominently.
- Other areas include **Renewable Energy Storage** (9), **Solar Thermal** (4), **Heat Pumps** (3), **Wind Energy** (3), **Geothermal Energy** (3), and small numbers in **Bioenergy/Biomass** (1) and **non-technological areas** such as policy and regulation (1).

Table 2: Number of courses by sector

Sector	Total Number of courses
Battery Storage (supporting Renewable Energy Systems)	37
Photovoltaic (PV) Solar	16
Solar Energy	10
Renewable Energy Storage	9
Solar Thermal (Concentrating and Non-Concentrating)	4
Heat Pumps	3
Wind Energy	3
Geothermal Energy	3
Other	2
Non-Technological (policy, funding, regulation)	1
Bioenergy/Biomass	1

By geography:

- The majority of programmes are **European-wide or country-agnostic** (68 courses), ensuring broad accessibility.
- **Germany** stands out as the main national hub with 12 courses, underlining its industrial and academic strength.
- Other contributions are more limited: **France (2), Denmark (1), Portugal (1), Spain (1), Romania (1), and the UK (1)**. A small number (3) are **Europe/Global**, highlighting challenges in balancing broad reach with local relevance.

Quality and alignment:

Courses were evaluated using four criteria: **relevance to labour market skills (40%),**

pedagogy/methodology (25%), alignment with standards and accreditation (25%), and accessibility (10%). Results show wide variability:

- **Renewable Energy Storage** and **Wind Energy** courses achieve the highest average quality scores (37% and 34%), reflecting strong skills coverage and robust delivery.
- **PV Solar** and **Battery Storage** courses score in the low 30s, with potential to enhance applied skills and methodologies.
- Sectors such as **Heat Pumps, Bioenergy/Biomass, and Geothermal Energy** lag behind (12–20%), underscoring critical training gaps.

Skills alignment:

High-scoring courses consistently integrate priority skills such as **data analysis, digital problem-solving, teambuilding, project management, and renewable energy technologies**, with strong role-specific relevance (e.g., wind turbine technicians, software developers). By contrast, low-scoring courses often lacked coverage of both core and role-specific skills, highlighting a need for updates to integrate **digital, interdisciplinary, and applied competencies**

The training supply is broad but uneven, with concentration in certain subsectors and gaps in others. Geographic distribution remains imbalanced, with Europe-wide offerings dominating while national ecosystems vary in quality and focus. To support the energy transition, future training strategies must prioritise **improving content alignment, expanding provision in underdeveloped subsectors, and embedding advanced digital and interdisciplinary skills** to ensure workforce readiness.

2.4.1. Methodology for Mapping Education and Training Programmes

The analysis of current education and training provision for renewable energy builds directly on the training offer mapping undertaken in D2.1 (Occupational Profiles and Needs Analysis). This work applied a structured, multi-step methodology to ensure that the programmes considered in the Skills Strategy are representative, comparable and aligned with European policy frameworks.

Scope and Data Sources

A total of **89 courses** relevant to renewable energy occupations were identified and analysed. These programmes span battery storage, solar PV and thermal, renewable energy storage, heat pumps, wind, geothermal, bioenergy/biomass and non-technological areas (e.g. policy, regulation).

The mapping focused primarily on European provision, with:

- 68 courses offered as "Europe-wide" or country-agnostic online/continental provision
- 12 courses based in Germany and a smaller number in France, Denmark, Portugal, Romania, Spain and the UK
- 6 transnational EU courses and a small set of Europe/Global offers.

Courses were identified through:

- Desk research of university and VET provider websites
- Sectoral and EU-level training catalogues and project outputs
- Inputs from project partners and stakeholder networks (industry associations, research institutes, training centres)
- Targeted searches for programmes explicitly linked to technologies or occupational profiles in scope (e.g. heat pumps, biogas plant operation, battery manufacturing).

This approach ensured that the mapping covered both formal qualifications (e.g. VET diplomas, higher education degrees) and non-formal continuing education (short courses, micro-credentials, industry/association training), while remaining manageable in scope.

Types of Providers and Levels of Education

The 89 courses span the main types of education and training providers relevant to the RES workforce:

- **Initial education (IVET and higher education)**
  - Vocational schools and technical colleges offering electrician, HVAC, industrial technician and related pathways.

- Universities and applied universities offering bachelor's and master's degrees in renewable energy, energy engineering, and related fields.

- **Continuing education (CVET and professional development)**
  - Private training providers, OEM/industry academies and sector associations delivering short courses on specific technologies (e.g. heat pump installation, SCADA/PLC operation, hydrogen safety).
  - Online training platforms and Europe-wide programmes offering modular and micro-credential-type courses.

Interview evidence confirms that further/continuing education is often closer to immediate industrial needs (e.g. biogas plant management, hydrogen-ready systems), while higher education tends to focus more on research and broader system knowledge. VET is critical for plant operators and technicians but is often perceived as too narrow and insufficiently updated for hybrid, digital and renewable-specific systems.

Dimensions Analysed: Content, Pedagogy and Delivery

Each course was coded along four dimensions, using a multi-criteria scoring rubric:

1. **Relevance** to high-demand skills and occupational profiles
   a. Alignment with the top 20 skills and top 5 skills per priority occupation identified in the labour-market analysis.
2. **Accessibility**
   a. Delivery mode (face-to-face, blended, online), language options, geographical reach, cost and scheduling flexibility.
3. **Methodology**
   a. Balance between theory and practice, level of learner interactivity, presence of hands-on labs, work-based learning or assessment mechanisms.

4. **Alignment and Recognition**

    a. Accreditation status, links to recognised standards or frameworks, currency and frequency of content updates, and (where available) explicit reference to **EQF levels or national frameworks**.

Scores were normalised and weighted (40% relevance, 25% methodology, 25% alignment, 10% accessibility) to generate a final quality score per course. This allowed the consortium to identify where training supply is strong and where it is either scarce or weakly aligned with RES skills needs.

Differences Between Initial and Continuing Education

Across the sample, several differences between **initial** and **continuing** education provision emerged:

- **Initial VET and HE programmes**
    - Typically, longer in duration (one semester to several years), mapped to national qualifications frameworks and thus indirectly to EQF levels.
    - Often strong on traditional electrical/mechanical foundations but slower to integrate automation, digitalisation, hydrogen, and circular economy skills.
- **Continuing VET and professional courses**
    - Shorter, modular formats (few days to a few weeks), sometimes offered as micro-credentials or manufacturer-specific training.
    - More agile in responding to emerging needs (e.g. hydrogen-ready boilers, hybrid systems, specific control platforms), but frequently lack explicit EQF (European Commission, 2008), referencing and are unevenly recognised across countries.
- **Learning objectives and pedagogy**
    - Initial education focuses on broad learning outcomes (e.g. “apply electrical principles”, “understand thermodynamics”) and general employability.

  - Continuous education prioritises task-specific, job-ready skills (e.g. commissioning of ASHP systems, biogas plant troubleshooting, SCADA configuration) and often uses practice-oriented or work-based learning.

The Skills Strategy therefore distinguishes between measures aimed at reforming initial VET and HE curricula and measures focused on scaling modular upskilling and reskilling offers for the current workforce.

EQF Levels, Training Gaps and Concentrations of Supply

The mapping of programmes was interpreted through the lens of the European Qualifications Framework (EQF) to improve comparability and to identify where training supply is concentrated or missing at different levels. For example, there is a strong concentration of training supply at EQF levels 6–7 (bachelor's and master's degrees), while provision at technician levels (EQF 3–5) is uneven. Similarly, battery energy storage shows a large number of courses at both technician and engineer levels (EQF 4–7), but gaps remain in advanced automation and digital skills. These patterns highlight the need to rebalance provision and systematically reference EQF levels in new trainings.

EQF as a Common Reference

The EQF (European Commission, 2008) is an 8-level, learning-outcomes-based meta-framework that covers all types of qualifications (school, VET, higher education, and adult learning) and serves as a translation tool between national systems.

- **Levels 3–4** typically correspond to upper-secondary VET and technician qualifications.
- **Level 5** often encompasses short-cycle higher education or advanced VET (e.g. higher technicians).
- **Levels 6–7** correspond broadly to bachelor's and master's degrees in higher education.

In many Member States, IVET programmes (e.g. 3-year programmes for electricians, HVAC installers or heat pump technicians) are mapped to EQF levels 3–4, while continuing VET (CVET) at technician/supervisory level often sits at levels 4–5 (Cedefop, 2020).

Concentrations of Training Supply by EQF Level

Although not all reviewed courses explicitly declared an EQF level, their target audience, prerequisites and awarding bodies allow several patterns to be identified:

- **Stronger concentration at higher education levels (EQF 6–7)**
  - Numerous bachelor's and master's programmes in renewable energy engineering, energy systems, and sustainability target EQF 6–7 learners.
  - These programmes tend to cover system design, policy and sustainability, but often under-represent hands-on skills and advanced digital competences relevant for technicians and plant operators.
- **Patchy provision at intermediate and technician levels (EQF 4–5)**
  - Interview and course evidence show structural shortages in VET-level provision for critical roles such as heat pump installers, gas technicians, and biogas plant operators, where many workers learn on the job or via short manufacturer training without clear EQF referencing.
  - While some countries offer well-structured IVET and CVET programmes at EQF 4–5 (e.g. electricians, HVAC), renewable-specific content (e.g. hybrid systems, hydrogen readiness, digital diagnostics) is often limited or optional.
- **Non-formal and micro-credential offers with unclear EQF mapping**
  - Many high-value short courses (e.g. SCADA for power plant operators, battery manufacturing QA, cybersecurity for grid operators) are offered by private providers or industry alliances and do not systematically state EQF levels.
  - This complicates **cross-border recognition** and makes it harder for workers to stack micro-credentials into recognised qualifications, despite EQF being designed to support

lifelong learning and validation of non-formal learning (European Commission, 2008).

Concrete Examples of Gaps and Overlaps

Linking the sample of 89 courses to EQF-like levels and occupational profiles reveals several gaps and concentrations of training supply:

- **Heat pumps, bioenergy and geothermal (Technician level – typically EQF 3–4)**
  - These subsectors show both **low numbers of courses** and **lower average quality scores**, with limited coverage of practical skills such as fault diagnosis, hybrid system integration, digital monitoring, or hydrogen readiness.
  - Many installers currently rely on ad-hoc upskilling via short, non-formal courses that are not referenced to EQF, making careers less transparent and limiting mobility.
- **Battery storage and renewable energy storage (Technician/Engineer level – EQF 4–7)**
  - Battery/storage shows a large number of courses and relatively good coverage of core skills but still exhibits gaps in advanced automation, programming and cloud-based monitoring.
  - Programmes cluster at higher education level (energy engineering, electrochemistry, materials science), while targeted technician-level training for operatives and maintenance staff is less visible.
- **Cross-cutting digital skills (EQF 4–7)**
  - Across EQF levels, courses frequently omit programming (e.g. Python), automation technologies, cloud systems, and system-level digital skills, even though these appear prominently in job ads for multiple RES occupations.
  - This creates a misalignment whereby workers at both technician and engineer level hold recognised qualifications but lack the digital layer of competences increasingly required on the job.

- **Transversal and management skills (EQF 5–7)**
    - Project management, leadership, stakeholder engagement and regulatory literacy are central to roles such as project managers, energy engineers and public sector planners, yet they are only partially integrated into many technical VET and HE curricula.

Implications for the RES Skills Strategy

Using EQF as a common reference highlights that the challenge is not only to "add more courses", but to:

- Rebalance training provision across levels, strengthening RES-specific IVET and CVET at EQF 3–5 for critical technician roles while maintaining high-quality HE programmes at EQF 6–7.
- **Systematically reference EQF levels** (and learning outcomes) in new micro-credentials and short courses so they can be stacked into recognised qualifications and easily compared across Member States.
- **Embed digital, automation and transversal competences** into qualifications at all levels, rather than treating them as optional add-ons.

These insights directly inform the recommendations in this Strategy regarding curriculum modernisation, modular pathways, micro-credentials, and the development of recognised, portable RES qualifications aligned with EQF, ESCO and Europass.

2.5 Future Proofing the Workforce The demand for renewable energy skills across Europe is far from uniform. Regional energy mixes, investment priorities, and policy frameworks shape very different labour market needs. Some countries in Northern Europe, for example Denmark, are a hotspot for offshore wind, creating strong demand for offshore installation and maintenance technicians as well as project engineers. Southern European countries such as Spain, Italy, and Greece are scaling up their solar, driving demand for solar installers and grid connection engineers. In Central and Eastern Europe, hydrogen pilot projects are increasing, requiring more chemical engineers and relevant safety compliance officers. Geothermal development is also advancing quite fast in Central and Eastern Europe, where geothermal energy systems, drilling expertise and reservoir management skills are of great importance. And across Europe, there are large-scale investments in battery storage and emerging hydrogen storage pilots, that also lead to specific job profiles and skills requirements.

These regional variations mean that while Europe faces a shared challenge of building a skilled workforce for the energy transition, the emphasis on which subsectors and roles matter most can differ considerably between countries. For instance, Germany's 2020 National Hydrogen Strategy has spurred publicly funded VET-programmes such as H2PRO, a BMBF/BIBB initiative that maps hydrogen-specific tasks in apprenticeships and defines new qualification needs. (BIBB, 2025). In Spain, the *Técnico Superior en Energías Renovables* is a 2,000-hour VET cycle offered in regional vocational schools covering wind, solar, substation and grid operations, combining classroom and in-company training (Ministerio para la Transición Ecológica y el Reto Demográfico, 2025). In the Netherlands, wind energy MBO programmes (for onshore/offshore) are developed in "learning communities" involving companies, schools and government (Noord Veluwe & Randmeergebied, 2020). And in Sweden, a twoyear Yrkeshögskola (YH) programme called *Drifttekniker med vätgaskompetens* ("Operation / Maintenance Technician with Hydrogen Competence") was launched in autumn 2024. The course was developed in collaboration with about 14 companies in the hydrogen industry to meet rapidly growing demand for hydrogenskilled technicians (Yrkeshögskolan SKY, 2024).

Stakeholders anticipate the growing importance of roles and skills related to:

- **Rising demand for hybrid professionals** who can work across physical infrastructure and digital systems.
- **Automation and robotics** will alter factory and maintenance roles.
- **AI and big data** will become core to predictive maintenance and energy system planning.
- **Circular economy skills**, including materials recovery and lifecycle design, will grow in relevance.
- **Reskilling opportunities** for fossil fuel workers are significant—but require structured, supported pathways.
- Fast-paced innovation in the energy sector will require more frequent upskilling of already qualified professionals. Due to workforce shortages and high demand for such professionals, upskilling options must be made easily accessible.
- Upskilling is also required for professionals already possessing a full skillset to be able to

integrate various technologies in one system (or provide fully integrated systems)

There is a clear shift from siloed technical roles to interdisciplinary, flexible profiles that can navigate both digital and physical energy environments.This analysis confirms that Europe's renewable energy workforce is facing:

- Severe shortages in technician and engineering roles.
- Misalignment between current training offers and emerging skills needs, especially when it comes to lifelong learning
- A growing gap in transversal and digital competences.

Addressing these challenges requires:

- Modernisation of some VET systems.
- Expansion of RE-specific training at all levels.
- Creation of upskilling opportunities using flexible and modular learning options, including micro-credentials where appropriate.
- Better integration of emerging digital and circular economy themes.

This evidence base forms the cornerstone of the RES Skills Strategy. By linking real-world labour demand with training and policy reform, it aims to support a smart, inclusive, and future-proof energy transition.

3. Challenges in the Renewable Energy Workforce

3.1. Identified Challenges

The renewable energy workforce across Europe is shaped not only by rapidly evolving technologies and ambitious deployment targets, but also by a series of systemic challenges that constrain skills supply and workforce readiness. These barriers, identified through surveys, interviews, workshops, and stakeholder contributions (including the Padlet exercise and extended consultation), highlight structural weaknesses that must be addressed for the skills strategy to succeed.

1. Awareness and Attractiveness of Careers

- Persistent undervaluation of vocational education and training (VET), reinforced by parental and institutional biases in favour of university pathways, as well as biases/stereotypes hampering gender diversity[3]
- Misguided perceptions of renewable energy careers, with technical roles (e.g., HVAC, plumbing) often portrayed as "dirty" or low-status, despite their strategic importance in the transition and the potential interest of candidates in the qualities and skillset required (i.e., beyond technical actions, those job profiles requires curiosity, troubleshooting, ability to be solution-oriented, etc.).
- Weak career narratives and limited visibility of both traditional and emerging roles (e.g., cybersecurity, energy data, circular economy).
- Gender imbalance remains: many clean energy roles remain male-dominated, especially in technical trades and hydrogen sectors.
- International managers and engineers, once trained, may leave the country, taking valuable expertise with them. Administrative hurdles further complicate the long-term stay of foreign labour.

2. Training Gaps and Teacher Shortages

- Upskilling provision lags behind industry developments in areas such as PV manufacturing, battery systems, hydrogen, and digitalisation, and integration to existing curricula is slow
- In some sub-sectors of the renewable energy, vocational training remains underdeveloped and is often misaligned with operational needs. Safety and operational risk management are insufficiently prioritised in existing training offers, while it is an acute need for employers.
- Shortages of qualified trainers: many educators lack up-to-date knowledge of modern systems (automation, AI, renewables). Shortage of trainers is worsened by low industry-to-teaching mobility programmes.
- Limited structured pathways or incentives for experienced industry professionals to transition

[3] In OECD countries, men hold about 72% of all "green jobs." This figure covers every type of position, not only technical roles where women are traditionally underrepresented.

into teaching roles.

- Lacking or outdated training equipment
- In some cases, (financial) incentives for companies to take on apprentices are lacking.

3. Fragmented and Misaligned Education Systems

- Inconsistent availability and quality of training across Member States.
- Over-reliance on short, uncertified courses while formal programmes remain outdated in some cases.
- Limited uptake of modular and micro-credentials for upskilling, slowed by bureaucratic hurdles.
- Weak alignment with EU frameworks for cross-border skills recognition, limiting labour mobility.
- Modular learning and micro-credentials are being piloted, but recognition remains limited across borders.

4. Economic and Structural Barriers

- Even where training is free, SMEs and workers face indirect costs such as lost time or productivity.
- Many SMEs lack the resources to provide structured training internally and depend on underfunded sectoral associations.
- Workers often resist upskilling where career progression and financial incentives are unclear.

5. Talent Shortages Across Critical Roles

- Structural shortages in technical occupations: renewable energy technicians, HVAC specialists, heat pump installers, operators of anaerobic digestion plants, and wind/solar engineers. In some sub-sectors, middle management roles and sustainability certification experts are also difficult to find.
- New employees often require long training periods due to the absence of basic industry knowledge and the narrow specialisation of available candidates.
- Emerging demand in non-technical roles: cybersecurity, permitting, regulatory affairs, project managers, and startup leadership.
- Public administrations face challenges in recruiting skilled staff for permitting and oversight

functions.

6. Undervalued Transversal and Interdisciplinary Skills

- Employers report gaps in problem-solving, adaptability, and interdisciplinary understanding (e.g., combining digital, regulatory, and engineering knowledge).
- Leadership, project management, and stakeholder engagement are underdeveloped in the current workforce, especially in SMEs and fast-scaling firms.
- Systems thinking and lifecycle are becoming more important, yet are rarely part of a technical training.
- Safety is a highly important skill

7. Digital and Future-Oriented Skills Gap

- Foundational digital skills (cybersecurity, automation, AI, data analysis) remain absent from many training pathways.
- Demand for grid digitalisation (smart grids) skills and AI in energy forecasting is rising, but many VET/HE programmes lag behind.
- Lack of strategic foresight and anticipatory skills to prepare for future market and technology shifts.

8. Knowledge Retention and Transfer

- A significant proportion of the workforce is approaching retirement age, with risks of knowledge loss in key trades.
- Mentorship and succession planning are often informal and unstructured, limiting cross-generational transfer.
- Retention risk is heightened as experienced international staff may leave, taking with them critical operational knowledge.

9. Cross-Border Challenges and Recognition of Skills

- Cross-border recognition of skills is limited.
- Limited coordination of qualification frameworks across EU countries, although several EU-level

initiatives and projects call for stronger cross-border recognition of credentials, particularly in emergent areas to enable worker mobility.

- Bureaucratic barriers hinder skilled migration and contribute to "brain drain" concerns.

Alongside these challenges, there are drivers and emerging opportunities for developing new training programmes in renewable energy. Public incentives such as the EU Just Transition Fund, national funding schemes for green skills, and tax credits for employer-led training are accelerating curriculum innovation. Additionally, under Pact for Skills, there is a Renewable Energy Skills Partnership that brings together multiple stakeholders to scale up upskilling and reskilling for the clean-tech workforce. There is also significant potential in reskilling displaced workers. For example, coal-industry workers often have complementary skills (e.g. working with complex machinery, willing to work in challenging environments) who can benefit from modular curricula to help them transition into renewable energy roles.

3.2.Towards a New Skills Strategy

These challenges highlight the structural misalignment between **labour market demand** and **skills supply** identified in D2.1. They confirm that while technical roles are urgently needed, transversal, digital, and future-oriented skills are equally critical to ensure resilience and adaptability.

The RES Skills Strategy will therefore prioritise:

- **Building generalised, modular training** that develops core skills transferable across subsectors and occupational profiles.
- **Supporting systemic change** in education and training to align provision with fast-evolving industry needs.
- **Promoting career attractiveness and mobility**, addressing both perception gaps and practical barriers to cross-border recognition.
- **Embedding transversal and digital competences** alongside technical training to prepare a workforce that is not only job-ready but also future-ready.

By explicitly addressing these challenges, the Strategy will act as a bridge between the sector's urgent demand for skills and the structural reforms required to deliver them at scale.

4. Skills Strategy

4.1 Recognised Education and Training programmes

Short Term (up to 2028) – Foundation and Initial Engagement

A coherent short-term strategy should focus on building a strong foundation for collaboration and curriculum alignment. To ensure that the strategy meets industry needs, education and training programmes will need to be jointly developed and validated by key renewable energy stakeholders, preferably at the national level, while maintaining coherence with European and global initiatives and projects. This joint design process should be anchored in a shared governance structure, with a collaborative framework – akin to a Sector Skills Alliance – established at the EU level for the renewable energy sector and ideally including local actors and authorities, while aligned with broader EU-level relevant collaboration platforms[4]. Initial partnerships may involve larger renewable energy firms, research institutes, and vocational education and training (VET) providers, supported by intermediary bodies that facilitate coordination between training institutions and employers.

Public financial support should be mobilised to accelerate initial training capacity building (under the EU funding programmes, such as the Cohesion Fund, the ERDF[5], or under specific national VET support schemes)[6]. Certain mechanisms must ensure equal participation from diverse stakeholders. Early engagement from social partners (employers' associations and unions) and policymakers will help align skills initiatives with labour market policy and funding. Curriculum co-design should start through advisory boards and regular workshops where educators and industry experts co-create course

[4] Pact for Skills, Net Zero Academies, EIT, Erasmus+ and Horizon Europe Projects, and other sector-specific initiatives
[5] European Regional Development Fund.
[6] Complementing the actions already foreseen under other projects and initiatives, e.g. under the Strategic Energy Technology (SET) Plan.

content. To bridge learning and practice, work-based learning components, such as internships or apprenticeships, should be embedded in training programmes as much as possible from this stage onwards. A structured process for periodic curriculum review should be established to maintain alignment with evolving technologies and regulations, drawing from existing partnerships that demonstrate early alignment between academia and industry.

Increasing alignment with European frameworks like ESCO[7] and the EQF[8] should be introduced in pilot courses to support recognition. Early public-private partnerships can provide equipment for training labs or technical expertise to support delivery. The Renewable Energy Skills Partnership under the EU Pact for Skills already exemplifies this approach – it "brings together leaders from the entire spectrum of the renewable energy value chain" and ensures "sustainable and systematic sectoral cooperation" on skills development (pact-for-skills.ec.europa.eu). Pilot courses should also consider early submission to European professional associations or bodies[9] to enable cross-country recognition of training programmes.

Medium Term (up to 2032) – Expansion, Standardisation, and Quality Assurance

In the medium term, the strategy should evolve from pilot efforts to a mature, standardised system for training excellence. The Sector Skills Alliance should expand to include SMEs, local authorities, and all relevant stakeholders, ensuring broad engagement and joint ownership of the skills agenda. Curriculum co-design should scale across multiple renewable energy disciplines, with frequent updates to include technological advances, regulatory changes, digital skills, and industry standards (e.g. SCADA systems, simulation tools, safety protocols for hydrogen and biogas). Curricula should also integrate emerging digital skills such as data analytics, IoT applications, and advanced simulation techniques.

Work-based learning must become systematically embedded, with co-supervision by employers to ensure graduates gain practical, industry-relevant experience. Robust quality assurance and

[7] ESCO: European Skills, Competences, Qualifications and Occupations: an EU framework that categorises and describes skills and occupations.
[8] EQF: European Qualifications Framework: a reference system that helps compare qualifications across EU countries.
[9] European Association for Quality Assurance in Vocational Education and Training (EQAVET), ropean Certification and Qualification Association (ECQA), European Digital Credentials for Learning (EDC), European Network of Qualifications Authorities (ENQA), Net Zero academies, Global Wind Organisation (GWO), etc.

accreditation mechanisms should be implemented, including development of renewable energy-specific training labels or certifications (for example, an EU-wide "RES Skills Quality Mark"). Peer review and feedback loops should be established, where industry partners assess graduate performance and suggest curriculum improvements. All programmes should be reviewed periodically to maintain relevance as technology and industry needs evolve. Mutual trust between learners and employers should be fostered, ensuring students graduate with competencies truly valued in the labour market.

Partnerships for curriculum innovation should broaden, involving universities, research centres, and innovation projects, including capstone projects linked to real industry R&D. Intermediary organisations or skills brokers should be used to link VET providers with industry partners, facilitating practical learning and placement opportunities.

Long Term (2032+) – Fully Integrated Skills Ecosystem

In the long term, a fully integrated European skills ecosystem should be established. A pan-European alliance for renewable skills should operate sustainably, continuously engaging all relevant stakeholders, including social partners, policymakers, and local authorities. All training programmes should be co-designed with continuous industry input, incorporating cutting-edge technology, digital skills, and emerging industry standards. A robust framework for cross-border recognition and accreditation should ensure that qualifications are respected by employers and authorities in all countries.

Mutual recognition of RES qualifications across Europe should be fully achieved, with certificates and credentials widely respected by employers and authorities in all countries. A fully integrated skills ecosystem will ensure that sector-specific alliances, aligned curricula, rigorous quality assurance, and continuous feedback collectively maintain a workforce fully prepared for current and future demands. Learners should have confidence that their qualifications are valuable and industry-relevant, while employers trust that graduates are fully competent and ready to meet emerging challenges.

4.2 Recognised Certifications across Europe

Short Term (up to 2028) – Alignment and Foundational Tools

The short-term strategic focus should be on establishing the foundations for mutual recognition and transparency. A cornerstone of this effort is aligning sectoral training with the European Qualifications Framework (EQF), which “makes national qualifications easier to understand and more comparable,” supporting cross-border mobility and lifelong learning. By referencing renewable energy courses and certifications to EQF levels, each qualification can be transparently mapped in terms of learning outcomes and proficiency. For example, a wind turbine maintenance certificate might be set at EQF level 5, ensuring that an employer in another EU country understands the skill level it represents.

Mutual recognition mechanisms should begin by defining core competencies and standards at the European level for key certifications (for instance, solar PV installers, energy auditors, wind farm safety training). Existing models, such as European Craftsperson Certificates or EN standards, can guide these initial steps.

At this stage, tools to ensure comparability and digital traceability should also be launched. Developing Certificate Supplements (as encouraged by Europass) for renewable energy qualifications can start in this phase, while early use of Europass Digital Credentials can streamline recognition. These digital credentials should be tamper-proof, electronically signed, and GDPR-compliant, leveraging the European Commission’s digital infrastructure for verification.

Medium Term (up to 2032) – Standardisation, Digitalisation, and Expansion

The medium-term objective should be to build a unified, digital, and modular certification system. Modular or micro-credentials should be supported so learners can build flexible, stackable qualifications referenced to EQF levels. Embedding EQF alignment across the sector will pave the way for automatic mutual recognition agreements where an RES credential earned in one member state is recognised in others.

Certificate Supplements should be systematically applied to qualifications across the sector to help authorities and employers abroad assess a candidate’s credentials. Issuing certifications as verifiable digital credentials should become widespread. Workers can carry secure, tamper-proof versions of their qualifications in an online “Skills Wallet,” with electronically signed certifications including learning outcomes and issuing institutions.

Digital badges and micro-credentials should support modular learning pathways, allowing workers to build portfolios that showcase comprehensive skill sets through Europass. Compatibility with EQF and Europass ensures that the principle of lifelong learning is upheld. The framework must accommodate varied forms of learning – formal VET diplomas, university degrees, short-course certifications, and on-the-job training attestations – all linked through a common reference. This structure builds mutual trust that employers and workers can rely on for cross-border mobility.

Sector stakeholders, via the Skills Alliance, should jointly define competency standards for each role to ensure consistency across training programmes.

Long Term (2032+) – Full Mutual Recognition and Labour Market Integration

By the long term, seamless cross-border recognition and integration of the renewable workforce should be achieved. Embedding the EQF in the certification framework should enable automatic mutual recognition agreements across member states. Better cross-border recognition will allow professionals to move freely where jobs are available without redundant retraining.

A pan-European certification system should increase employer confidence and reduce skills mismatches. Companies will be more willing to recruit internationally if they trust that a certification signifies the same competency level regardless of origin. The framework should maintain flexibility for sector-specific validation pathways and integration of national safety frameworks, ensuring inclusivity and compliance. Standardised certifications can embed EU safety and quality standards consistently, facilitating cross-border staffing of renewable energy projects.

National agencies can continue awarding certifications but translate them to the EU framework using EQF levels and standard competency descriptions. The sector's alliance could maintain an online registry of recognised renewable energy credentials.

Ultimately, the long-term vision is a trusted European certification system that turns skills into a universal currency for the green labour market, enabling mobility, efficiency, and confidence across borders. Workers can carry verified, GDPR-compliant digital qualifications, and employers can rely on a Europe-wide "Skills Passport" to verify competencies instantly, accelerating deployment of talent across countries.4.3 Promoting RES Careers to Youth and Jobseekers

Short Term (up to 2028) – Awareness, Visibility, and Early Outreach

The short-term priority should be to raise awareness and ignite enthusiasm for renewable careers among young people and jobseekers. Inspiring the next generation to pursue renewable energy careers is crucial for building a continuous talent pipeline. Proactive outreach campaigns, educational initiatives, and youth-friendly communication strategies should highlight the excitement, purpose, and high-tech, innovative nature of green careers.

Efforts should begin with an increased presence in career fairs, along with a coordinated European communication campaign to revive the sector's image as dynamic and technology driven. Participation in career fairs includes events dedicated to would-be and current university students, showing the diversity of renewable energies and their associated career paths, from technical to managerial profiles. Sub-sectors with lower public awareness, such as biogas or geothermal, will particularly benefit from such actions. Renewable Energy Career Roadshows and interactive demonstrations (e.g. virtual wind farm tours or solar car races) will enhance the impact of such awareness-raising campaign. Parallel to such local actions, a European media campaign across media channels in national languages should reinforce the shift in public perception among jobseekers and students.

The EU and member states should leverage existing youth programmes (such as Erasmus+ and national STEM initiatives), apprenticeships, and VET tracks to integrate renewable energy themes, encouraging early exploration of solar, wind, biogas, and other fields. Targeted outreach should engage underrepresented groups – young women, vocational students, workers in transition regions, and reskilling adults – ensuring inclusivity. Outreach should also engage ethnically diverse youth to ensure equal access to emerging career paths.

Engaging content on social media (e.g. TikTok or YouTube "day in the life" videos) should portray renewable energy as impactful, innovative, and high-tech. A unified communication toolkit for industry, employment agencies, and career advisors can support consistent messaging across Europe.

Medium Term (up to 2032) – School Integration, Targeted Messaging, and Role Model Deployment

In the medium term, outreach should evolve into structured education and mentoring initiatives. Ministries of Education should integrate renewable energy into school curricula and career guidance.

Partnerships with industry can deliver projects such as energy camps, junior clean-tech competitions, hands-on classroom projects (mini solar panels or windmill models), coding challenges, and smart grid exercises, while field trips to renewable facilities and short-term internships make learning tangible.

Establishing RES ambassadors or “Green Career Champions” who visit schools should become routine. Guidance materials for teachers, parents, and counsellors should clarify pathways into renewable professions.

Communication should promote a strong narrative: renewable energy careers are future-proof, innovative, and impactful, allowing young people to contribute to Europe’s climate transition. Highlighting technology, diversity, real career progression, and the breadth of opportunities (research, product development, digital grid management, environmental science) will make the message compelling. Role models – including women, entrepreneurs, professionals from diverse backgrounds, and social media influencers or content creators – should be featured prominently through media and live events. A European “Green Jobs Ambassador” programme could be formalised to coordinate this outreach across countries.

Long Term (2032+) – Normalisation, Large-Scale Engagement, and Sustained Talent Attraction

The long-term strategic aim is to embed renewable careers as a normal, attractive choice for all generations. Ongoing campaigns, youth events, and industry partnerships should sustain public interest. Annual initiatives such as a “Youth in Green Energy” hackathon or an EU Sustainable Energy Youth Day could celebrate youth innovation in renewables.

By communicating a consistent vision – that RES careers offer growth, innovation, and meaningful impact, and the chance to contribute to Europe’s climate transition – the sector can maintain long-term momentum. Over time, renewable energy should become a mainstream career aspiration, supported by embedded education, visible role models, digital ambassadors, and strong institutional collaboration.

5. Recommendations and conclusions

5.1 Summary of Key Findings

The renewable energy sector is one of the fastest growing job markets in Europe, but also one of the most constrained by structural skills shortages and fragmented training ecosystems. The analysis in Chapters 2 and 3 highlights several interconnected findings:

1. Occupational Profiles in Demand

- **Technicians and Skilled Workers** (e.g., solar installers, wind turbine technicians, biogas plant operators, HVAC specialists, electricians) face the most acute shortages. For instance, the EU has a **severe scarcity of qualified electricians** capable of handling PV, heat pump, and battery integration, delaying building retrofits and grid connections.
- **Engineering roles** (e.g., energy engineers, industrial engineers, renewable consultants) are in high demand, particularly those able to bridge **technical expertise with digital and regulatory knowledge**. Cross-domain engineers are vital to manage hybrid systems and smart grids.
- **Emerging roles** (cybersecurity experts, AI specialists, SCADA programmers, circular economy professionals) are rapidly growing, but training provision is almost non-existent.

2. Skills in Demand

- **Technical skills**: mechanical/electrical engineering, installation and maintenance protocols, grid integration, fluid dynamics, and quality control remain the backbone.
- **Digital skills**: SCADA systems, PLC programming, AI and predictive maintenance, CAD/simulation tools, and cybersecurity are becoming mainstream requirements across subsectors.
- **Transversal skills**: project management, systems thinking, stakeholder engagement, and

regulatory literacy are essential but undervalued.

3. Structural Challenges

- **Awareness and attractiveness**: VET remains undervalued compared to university pathways, and many technical roles suffer from outdated stereotypes. Gender imbalance is particularly acute in trades and hydrogen-related sectors.
- **Training gaps and teacher shortages**: many educators lack up-to-date knowledge of automation, AI, and new renewables; mobility between industry and teaching roles is limited.
- **Fragmented education systems**: misalignment across Member States limits comparability of qualifications; micro-credentials and modular pathways exist but lack recognition.
- **Economic and structural barriers**: SMEs cannot afford extensive training; workers are reluctant to reskill without clear career progression or pay incentives.
- **Knowledge retention**: ageing workforce in key trades, with weak mentorship systems for knowledge transfer.
- **Cross-border recognition**: despite frameworks like **EQF** and **ESCO**, renewable-specific certifications remain fragmented, slowing labour mobility at a time when projects need mobile talent.

4. Regional Variations

- **Northern Europe**: offshore wind creates demand for specialised installation technicians and project managers.
- **Southern Europe**: booming solar PV markets require thousands of installers and grid engineers.
- **Central & Eastern Europe**: hydrogen pilots and geothermal projects demand chemical engineers, safety officers, and drilling specialists.
- **Across Europe**: battery storage and digital grid expansion generate transversal needs for system integrators and industrial engineers.

In summary, the sector's workforce challenge is not only one of **quantity** but also of **quality, adaptability, and recognition**. Europe must urgently modernise its training, create portability of skills, and improve the attractiveness of renewable careers to meet its climate and industrial policy goals.

5.2 Recommendations for a Unified European Skills Energy Strategy

The recommendations are organised around three interlinked **strategic pillars** that together form the foundation of a coherent European Renewable Energy Skills Ecosystem.

Pillar 1: Education and Training

Short-term (2025–2028): Build Foundations

- **Update and align curricula** across VET and HE institutions with the latest renewable energy technologies (solar PV, wind, hydrogen, biogas plants, grid integration, storage).
- Develop **modular, micro-credential-based programmes** for upskilling and reskilling in critical occupations, ensuring alignment with ESCO and EQF.
- Launch **educator capacity-building initiatives** (train-the-trainer schemes, digital teaching resources) to address trainer shortages and accelerate innovation in teaching methods.
- Establish **national and regional renewable skills partnerships** involving employers, training providers, and policymakers to coordinate immediate training responses.

Pilot digital learning environments that support blended and remote learning for technical and cross-sectoral skills.

Medium-term (2028–2032): Scale and Integrate

- Mainstream **skills forecasting and intelligence systems** to enable responsive and evidence-based planning of training supply.
- Embed **AI and data analytics tools** to predict workforce needs and optimise training pathways.

- Integrate **green and digital transversal competences** (e.g., sustainability literacy, data use, digital safety) across all renewable energy education and training programmes.
- Strengthen cooperation between **universities, VET centres, and industry clusters** through joint labs, apprenticeships, and innovation hubs[10].
- Promote **teacher mobility and exchange** across Member States to support capacity building and harmonisation of skills standards.

Long-term (Beyond 2032): Sustain and Innovate

- Institutionalise **lifelong learning frameworks** enabling continuous professional development throughout the renewable energy career lifecycle.
- Develop **cross-sectoral pathways** between renewable energy, construction, transport, and ICT to foster interdisciplinary skills mobility.
- Establish **a European Academy for Renewable Skills and Technologies** to serve as a central node for training excellence, innovation transfer, and policy alignment.

Actors involved are VET centres and higher education institutions, industry employers and clusters, EU agencies, trade unions, national ministries, sectoral associations, regional authorities, and research institutes.

Good practice examples include the Renewable Energy Skills Partnership under the EU Pact for Skills, Blueprints such as ALBATTS within the battery sector, the German Biogas Training Network, Net Zero Academies such as European Battery Academy, European Solar Academy and European Hydrogen Academy, and Centres of Vocational Excellence (CoVEs).

Pillar 2: Certification and Quality Assurance

Short-term (2025–2028): Strengthen Standards

[10] As an example, the German biogas, waste and wastewater sectors set up Biogas Training Network, designing five specialised courses that are delivered by VET providers across Germany. For more information: https://www.schulungsverbund.biogas.org/schulungsangebot

- Map existing national **qualification and certification systems** to identify gaps and overlaps in renewable energy training provision.
- Develop a **European framework for mutual recognition** of renewable energy qualifications under EQF and Europass.
- Introduce **standardised competency profiles** for priority occupations to ensure comparability across countries and providers.
- Pilot **digital certification systems** (e.g., verifiable credentials) to increase transparency and portability of skills documentation.

Medium-term (2028–2032): Harmonise and Expand

- Establish a **Renewable Skills Quality Assurance Network** to harmonise validation processes, quality benchmarks, and cross-border recognition procedures.
- Integrate **sustainability and safety criteria** into all renewable energy certification schemes, ensuring workforce resilience and compliance with evolving EU standards.
- Incentivise the use of **accredited providers** and EU-aligned certification to increase mobility and employability.
- Link certification databases with **labour market and skills observatories** to monitor uptake, demand, and progression.

Long-term (Beyond 2032): Consolidate Recognition

- Achieve **EU-wide interoperability** of renewable energy certifications through shared digital infrastructure and recognition agreements.
- Create a **pan-European certification registry** for renewable energy occupations, enabling cross-border verification and benchmarking.
- Embed renewable energy qualifications within the **European Skills Data Space**, connecting education outcomes with labour market intelligence.

Actors involved are national qualifications authorities, accreditation bodies, EU agencies, Europass and ECQA platforms, employers, digital credential platforms, and labour market observatories.

Good practice examples include Cedefop and ETF guidance on greening VET, and quality assurance and bodies such as Europass and ECQA.

Pillar 3: Youth and Career Promotion

Short-term (2025–2028): Raise Awareness

- Launch a **Europe-wide communication campaign** to increase the attractiveness of renewable energy careers, targeting schools, VET learners, and underrepresented groups.
- Promote **role models and ambassadors** (especially women and young professionals) through digital storytelling, media partnerships, and events.
- Establish **career guidance resources** showcasing renewable energy job profiles, skills pathways, and labour mobility opportunities.

Medium-term (2028–2032): Expand Engagement

- Integrate renewable energy topics into **school and VET curricula** to foster early interest in STEM and sustainability careers.
- Build **regional youth innovation hubs** and competitions focused on renewable technologies and entrepreneurship.
- Partner with **European youth organisations** to co-design mentoring, internship, and mobility programmes.
- Ensure **inclusive access** to renewable training programmes through targeted scholarships and outreach initiatives.

Long-term (Beyond 2032): Empower the Next Generation

- Embed renewable energy and sustainability careers within the **European Education Area** as core growth sectors.

- Develop **European Green Career Pathways** that connect school education, training, higher education, and industry.
- Establish an annual **EU Renewable Skills Week** celebrating youth engagement, innovation, and mobility in the green transition.

Actors involved are career guidance services, public employment services, schools and VET providers, youth organisations, NGOs, media partners, employers (apprenticeship and internship providers), EU agencies, and diversity and inclusion actors.

Good practice examples include youth mobility and mentoring pilots under the Renewable Energy Skills Partnership and Erasmus+ mobility and green skill projects.

Conditions for Successful Implementation

Across all pillars and timelines, successful implementation depends on:

- **Policy alignment** across EU, national, and regional levels (e.g., Pact for Skills, Net-Zero Industry Act).
- **Sustainable funding mechanisms**, leveraging Erasmus+, ESF+, and Horizon Europe.
- **Data integration** through the European Skills Intelligence and Foresight Platform (ESCO, CEDEFOP, ETF).
- **Inclusive governance** ensuring representation of SMEs, social partners, and civil society.

5.3 Conclusion

The renewable energy transition represents one of Europe's most significant industrial transformations — and its success hinges on people as much as on technology. The findings presented in this strategy reveal a workforce landscape marked by high demand, uneven training provision, and untapped potential across regions and demographics.

To meet the EU's 2030 and 2050 climate and industrial goals, Europe must move from fragmented national initiatives to a **coordinated, EU-wide skills ecosystem**. This strategy outlines the path forward:

- **Short term (to 2028):** build foundational partnerships, pilot aligned curricula, and begin mutual recognition of renewable energy qualifications.
- **Medium term (to 2032):** scale sectoral alliances, standardise quality assurance, and digitise certification systems via Europass and EQF.
- **Long term (beyond 2032):** achieve full cross-border portability of qualifications, a pan-European renewable skills alliance, and continuous innovation through lifelong learning.

The transition must also be **inclusive** — ensuring gender balance, youth participation, and opportunities for workers in transition regions. Promoting renewable careers among young people, empowering trainers, and embedding transversal and digital skills are all critical to sustaining the momentum of the green transition.

Ultimately, the renewable energy transition is not just an environmental or technological challenge — it is a **skills revolution**. By investing in people, modernising education and training, and aligning policy with practice, Europe can accelerate its journey to net zero while fostering prosperity, innovation, and resilience across all regions.

The benefits will be clear: faster deployment of renewables, stronger industrial competitiveness, and inclusive opportunities across regions. Skills are the currency of the clean energy transition — Europe must invest in them now to achieve its **2030 renewable targets** and **2050 climate neutrality**.

6. List of references

REskill 4NetZero
Boosting Green Energy Careers

BIBB: H2PRO – are our training occupations H2-ready? Available at: https://www.bibb.de/en/153309.php [Accessed 25 November 2025].

CEDEFOP: Policies to increase training provision in micro, small and medium-sized enterprises: Case studies. [pdf] Available at: https://www.cedefop.europa.eu/files/5606_en_case_studies.pdf [Accessed 13 November 2025].

Cedefop (2017) *European Qualifications Framework (EQF) – Agreed Learning Outcomes and Level Descriptors*. Thessaloniki: Cedefop.

Cedefop (2020) *Vocational Education and Training in Europe: Developments and Challenges*. Luxembourg: Publications Office of the European Union.

Cedefop (2023) *Microcredentials for Lifelong Learning and Employability*. Publications Office of the European Union.

European Training Foundation (2022) *The Future of VET in a Digital Age*. Turin: ETF.

European Commission. (n.d.) *European Skills, Competences, Qualifications and Occupations (ESCO).* Available at: https://esco.ec.europa.eu/en (Accessed: 25 November 2025).

European Commission (2008) *Recommendation of the European Parliament and of the Council on the establishment of the European Qualifications Framework for lifelong learning (EQF)*. Official Journal of the European Union, C111/1.

European Commission (2019) *The European Green Deal*. COM(2019) 640 final. Brussels: European Commission.

European Commission (2020) *European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience*. Available at: https://ec.europa.eu (Accessed: 25 November 2025).

European Commission (2022) *REPowerEU Plan*. COM(2022) 230 final. Brussels: European Commission.

European Commission (2023a) *Net-Zero Industry Act*. COM(2023) 161 final.

European Commission (2023b) *Europass Digital Credentials Framework*. Available at: https://europa.eu/europass (Accessed: 25 November 2025).

European Commission (2023c) *Proposal for a Regulation on Establishing a Framework of Measures for Strengthening Europe's Net-Zero Technology Products Manufacturing Ecosystem (Net-Zero Industry Act)*. COM(2023) 161 final. Brussels: European Commission.

European Commission (2022). *GreenComp: The European sustainability competence framework.* [online] Available at: https://joint-research-centre.ec.europa.eu/greencomp-european-sustainability-competence-framework_en [Accessed 25 November 2025].
European Commission (2020). *EU Taxonomy for sustainable activities.* [online] Available at: https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en [Accessed 25 November 2025].European Parliament and Council (2008) *Recommendation on the establishment of the European Qualifications Framework for lifelong learning (EQF)*. Official Journal of the European Union, C111.

EUREC (2025) *Renewable Energy Skills Partnership: New Policy Statement on Micro-Credentials and Certification*. [online] 29 September. Available at: https://eurec.be/renewable-energy-skills-partnership-new-policy-statement-on-micro-credentials-and-certification/ [Accessed 13 November 2025].

Ministerio para la Transición Ecológica y el Reto Demográfico *Ciclo Formativo de Grado Superior - Energías Renovables.* [online]Available at: https://www.miteco.gob.es/eu/ceneam/formacion-ambiental/formacion-reglada/energias-renovables.html [Accessed 25 November 2025].

OECD (2023) Empowering women to power the green transition. [pdf] Available at: https://oecdcogito.blog/2023/03/08/empowering-women-to-power-the-green-transition/ [Accessed 5 November 2025]

OECD (2024) Battery Training Center case study. [pdf] Available at: https://www.oecd.org/en/publications/providing-local-actors-with-case-studies-evidence-and-solutions-places_eb108047-en/battery-training-center_9a6ba0f5-en.html [Accessed 13 November 2025]

ReSkill4NetZero
Boosting Green Energy Careers

ReSkill4NetZero (2025) *D2.1 Occupational Profiles and Needs Analysis*. Erasmus+ Project Deliverable, Grant Agreement 101186624.

Noord Veluwe & Randmeergebied (2020) *Techniekpact*. [pdf] Available at: https://www.platform-techniek.nl/wp-content/uploads/2020/04/Techniekpact-2020.pdf [Accessed 25 November 2025]

Yrkeshögskolan SKY (2024) *Drifttekniker med vätgaskompetens.* [online] Available at: https://yhsky.se/utbildningar/drifttekniker-med-vatgaskompetens [Accessed 25 November 2025]

Annexe 1

Summary of Methodologies and Data Sources Used for the Needs Analysis

This annexe provides a concise overview of the methodologies and data sources used for the skills needs analysis underpinning the RES Skills Strategy. It consolidates the approaches applied in Deliverable D2.1 (Occupational Profiles and Needs Analysis) and complementary research conducted across Work Package 2. The aim is to ensure transparency, comparability and coherence in how skills demands, occupational profiles and training gaps were identified across the EU.

1. Overview of Methods Used in the Needs Analysis

Method	Description
Documentary Research	Review of 36 EU and national industry reports, regulatory documents, and labour-market publications.
Job Market Analysis	Analysis of 70,000 job advertisements (42,037 after cleaning) using NLP-based extraction of occupations and skills.
Surveys	Two workforce surveys conducted in 2023 and 2025 with 154 and 34 respondents across 21 and 14 countries.
Expert Interviews	Nine interviews with industry experts in wind, solar, hydrogen, bioenergy, batteries, geothermal and grid operations.
Training Offer Mapping	Review of 89 courses across Europe (VET, HE, micro-credentials, industry training) assessed using relevance, pedagogy, alignment and accessibility criteria.
ESCO/EQF Alignment	Mapping of occupations and skills to ESCO concepts and indicative EQF levels to ensure EU coherence.

Key Data Sources Used

Category	Source	Scope / Volume
Industry & Policy Reports	Sector reports, NECPs, regulatory frameworks	36 reports reviewed
Job Advertisements	European job boards and labour platforms	70,000 ads (42,037 after cleaning)
Surveys	Workforce surveys (2023, 2025)	154 + 34 respondents across 21 + 14 countries
Expert Interviews	Semi-structured interviews	9 interviews across RES technologies
Training Programmes	VET, HE, professional training offers	89 courses reviewed across multiple EU countries

Summary of Country-Level Insights

- Northern Europe (e.g., Denmark, Germany): Strong VET systems but shortages in offshore technicians and advanced digital skills.
- Southern Europe (e.g., Spain, Italy, Greece): High deployment needs in solar and heat pumps, but fragmented training provision and shortages of certified installers.
- Central and Eastern Europe (e.g., Poland, Romania, Czech Republic): Gaps in hydrogen-ready and digital skills; limited practical training infrastructure.
- Western Europe (e.g., France, Netherlands): Strong engineering programmes but gaps in technician-level RES-specific VET.
- Cross-border observation: Significant variation in licensing and recognition of electrician and HVAC qualifications, limiting mobility.

Annexe 2

1. Most Frequently Requested Skills by Occupational Profile

Occupational Profile	Top 10 Most Demanded Skills (from job ads, surveys, ESCO mapping)
Renewable Energy Technicians (Solar/Wind/Geothermal/Heat Pumps)	1. Electrical wiring & connection (ESCO: “install electrical systems”) 2. Mechanical assembly & troubleshooting 3. System integration (PV, heat pumps, inverters) 4. Preventive & corrective maintenance 5. Health & safety compliance (ESCO: “apply OSH legislation”) 6. HVAC & refrigerant handling (for heat pumps) 7. Diagnostics & fault detection 8. Use of digital monitoring tools (SCADA-lite, OEM tools) 9. Customer communication 10. Environmental-safe installation practices
Gas Technicians (Biogas / Hydrogen)	1. Gas safety protocols (ESCO: “ensure gas safety”) 2. Leak detection & system testing 3. Installation of gas pipelines & injection systems 4. Digital monitoring & sensor systems 5. Maintenance of biogas/hydrogen equipment 6. Regulatory compliance & environmental standards 7. Diagnostics & fault resolution 8. Reading technical drawings & specifications 9. Pressure systems knowledge 10. Emergency response procedures
HVAC & Refrigeration Technicians	1. HVAC installation & commissioning 2. Troubleshooting cooling/heating systems 3. Energy-efficiency optimisation 4. Refrigerant safety & leak detection 5. System integration with heat pumps 6. Electrical/mechanical diagnostic skills 7. Standards & regulation compliance 8. Customer service & documentation 9. Digital controllers & BMS familiarity 10. Maintenance & periodic inspection
Electricians (Domestic & Industrial)	1. Low/high voltage electrical systems

	2. DER integration (PV, EV chargers, heat pumps) 3. SCADA/PLC basics (industrial electricians) 4. System testing & commissioning 5. Electrical safety standards 6. Troubleshooting & diagnostics 7. Cable routing & containment 8. Reading schematics/drawings 9. Smart inverter setup & configuration 10. Customer communication
Energy Engineers	1. System design & optimisation 2. Digital twins & modelling 3. SCADA integration & monitoring 4. Circularity & lifecycle assessment 5. Energy system analysis (ESCO: "conduct energy audit") 6. Project planning & management 7. Data analysis & modelling (Python, MATLAB) 8. Technical documentation 9. Sustainability strategy & compliance 10. Cross-functional coordination
Renewable Energy Consultants	1. Feasibility studies (site, design, sizing) 2. Permitting & regulatory literacy 3. RE system design 4. Stakeholder communication 5. Project coordination 6. Technical report writing 7. Market & policy knowledge 8. Risk assessment 9. Digital tools (GIS, CAD, modelling) 10. Client advisory & communication
Industrial Engineers (Manufacturing / Batteries / PV)	1. Industrial process optimisation 2. Industry 4.0 tools (automation, robotics) 3. Quality assurance & testing 4. Lean manufacturing principles 5. Digital twins & PLCs 6. Data-driven decision making 7. Equipment maintenance 8. Safety protocols 9. Industrial design tools (CAD/CAM) 10. Production line monitoring
Factory Operatives / Maintenance Staff	1. Machine operation & monitoring 2. Quality control & inspection 3. Process troubleshooting 4. Safety protocols

	5. Basic digital literacy 6. Logistics/coordination 7. Equipment maintenance basics 8. Assembly skills (PV, batteries) 9. Process documentation 10. Use of measurement tools
Power Plant Operators (Wind/Solar/Biogas)	1. SCADA system operation 2. PLC programming basics 3. Real-time system monitoring 4. Diagnostics & troubleshooting 5. Maintenance planning 6. Safety & regulatory compliance 7. Sensor calibration & data interpretation 8. Reporting & documentation 9. Digital control interfaces 10. Fault response protocols
Health & Safety Professionals (RE sector)	1. RE-specific safety protocols (wind, heat pumps, biogas) 2. Risk assessment & mitigation 3. Hazard detection 4. Compliance with EU safety codes 5. Emergency response planning 6. Refrigerant safety (heat pumps) 7. Permit management 8. Site audits & inspections 9. Training delivery & communication 10. Incident reporting
Planners / Regulatory & Permitting Specialists	1. Permitting processes & regulatory literacy 2. GIS & spatial planning tools 3. Policy interpretation (EU, national) 4. Renewable technology fundamentals 5. Stakeholder engagement 6. Project management 7. Environmental impact assessment 8. Data-driven decision making 9. Digital mapping & modelling 10. Documentation & compliance
Project Managers (Cross-cutting role)	1. Project lifecycle management 2. Budgeting & resource planning 3. Multi-stakeholder coordination 4. Risk management 5. Digital tools (MS Project, Primavera) 6. Technical understanding of RE tech 7. Reporting & communication

	8. Quality management 9. Contract & procurement knowledge 10. Offshore/onshore safety awareness
Emerging Digital Roles (AI, SCADA, Cybersecurity, Analytics)	1. Programming (Python, SQL, C++) 2. Data analysis & ML techniques 3. SCADA/PLC programming 4. Cybersecurity fundamentals 5. Digital twins & modelling 6. Automation systems 7. Systems integration 8. Cloud platforms & APIs 9. Predictive maintenance analytics 10. Documentation & technical reporting

2.Thematic Grouping of Occupational Profiles in the Renewable Energy Sector

A. Technical & Installation Roles

Renewable Energy Technicians
Gas Technicians (Biogas/Hydrogen)
HVAC & Refrigeration Technicians
Electricians (Domestic/Industrial)

▼

B. Engineering & Design Roles

Energy Engineers
Renewable Energy Consultants
Industrial Engineers

▼

C. Manufacturing & Operational Roles

Factory Operatives / Maintenance

Power Plant Operators
Health & Safety Professionals

|
▼

| D. Strategic, Planning & Support Roles |

Planners (Permits, Regulation)
Project Managers
Regulatory/Compliance Specialists

|
▼

| E. Emerging Digital & Hybrid Roles |

SCADA Programmers
AI/Machine Learning Specialists
Cybersecurity Analysts
Energy Data Analysts
Retrofitting Experts (Hybrid role)

This diagram groups roles into five thematic clusters reflecting the renewable energy labour market structure:

- **A: Technical roles** → hands-on installation, maintenance, integration
- **B: Engineering roles** → design, analysis, optimisation
- **C: Manufacturing/operations** → production & plant operation
- **D: Strategic/planning roles** → regulatory processes, project management
- **E: Emerging digital roles** → automation, AI, SCADA, cybersecurity