Co-funded by
the European Union

P4ELECS
Platform for
Electrification Skills
& Competences

Report: P4ELECS

D2.2
Model for Skills Intelligence
Skills Mapping

ERASMUS-EDU-2023-PEX-COVE PROJECT ID 101144017

ISSO

www.p4elecs.com

LegaL Disclaimer
Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union of the European Education and Culture Executive Agency (EACEA). Neither the European Education Union nor EACEA can be held responsible for them.

PROJECT INFORMATION

Project Title	**PLATFORM FOR ELECTRIFICATION SKILLS and COMPETENCES**
Project Acronym	P4ELECS
Project ID	101144017 - ERASMUS-EDU-2023-PEX-COVE
Funding Scheme	Partnership for Excellence – Centres of Vocational Excellence
Web Address	https://p4elecs.com
Coordination Institution	KU Leuven
Project Duration	15/3/2024 – 14/3/2028

DELIVERABLE DETAILS

Deliverable No.	D2.2
Deliverable Type	R – Document, report
Dissemination Level	Public
Work Package no	2
Work Package Title	Model for Skills Intelligence – Skills Mapping
Task no	T2.3
Task Title	Skills mapping for the topics of the spiders and development of Unit of Learning Outcomes
Authors	Lilibeth Juarez (ISSO), Martijn Van Bommel (ISSO)
Status	Final
File name	D2.2_Model for Skills Intelligence – Skills Mapping
Version no	V1.0
Task start date and duration	1/4/2024 – 14/3/2026
Due Date	M24 (14/3/2026)
Delivery Date	12/03/26

REVIEW HISTORY OF DELIVERABLE

Version no.	Date	Revision Details	Reviewer	Organisation/Institute
V0.1	*8/5/25*	First Draft	An Verburgh	UCLL
V0.2	*12/12/25*	Reviewed Version	An Verburgh	UCLL
V1.0	*14/3/2026*	Final	Annick Dexters	KU Leuven

Summary

This report presents Deliverable D2.2 – Model for Skills Intelligence, developed within Work Package 2 of the ERASMUS+ P4ELECS project. The report introduces the ISSO Skills Intelligence Model, a structured methodology for identifying emerging skill needs in the skills ecosystem and translating them into Units of Learning Outcomes (ULOs). These ULOs form the basis for developing training materials and courses.

Rapid technological innovation creates a continuous demand for new competences. Education and training systems often adapt more slowly, which leads to shortages of professionals who can combine technical, digital, and interdisciplinary skills. The ISSO Skills Intelligence Model addresses this challenge. It offers a systematic approach to identify current and future skill gaps and translate them into modular learning content that aligns with industry needs.

ISSO developed the model in collaboration with UCLL and applied it within the P4ELECS project to innovations in the energy and mobility domains. The model connects technological innovation with skills development. It does this by analysing emerging technologies, identifying affected occupations, and mapping the required competences through expert consultation and structured skills analysis.

The report is organised into five main sections:

1. **Introduction to the ISSO Skills Intelligence Model;**
   This section explains the conceptual background of the model and its relation to the innovation lifecycle. The approach is inspired by the innovation system functions described by Hekkert and Suurs.

2. **Skills Mapping;**
   This section describes how experts from education, industry, and research work together to identify relevant occupations, tasks, and responsibilities related to technological innovations.

3. **Development of Units of Learning Outcomes (ULOs);**
   This section explains how validated tasks are translated into structured learning outcomes consisting of knowledge, skills, and attitudes, in line with European guidelines.

4. **Outcomes and impact;**
   This section summarises the insights gained from the analysis of skill needs and the development of ULOs within the P4ELECS innovation domains.

5. **Conclusions and recommendations.**
   This section provides guidance for implementing, scaling, and integrating the Skills Intelligence Model within regional and European skills ecosystems.

Key elements of the methodology include:

- The use of the **ULO Generator tool** to translate occupational tasks and responsibilities into structured learning outcomes;
- A **collaborative validation process** involving stakeholders from education, industry, and research.

This approach supports flexible, modular, and evidence-based curriculum development.

The report demonstrates that the ISSO Skills Intelligence Model provides a transferable framework for aligning education and training with technological innovation and labour market needs across different EQF levels. The model also supports the development of Building Blocks (BBs), courses, and micro-credentials, enabling education and training systems to respond more effectively to emerging technological developments.

These strategies collectively address the pressing question: *How can education & training systems evolve to meet the challenges of emerging technologies in a rapidly changing job market?*

TABLE OF CONTENTS

GLOSSARY

BBs	Building Blocks
CDIO	Concept Design Implement Operate
CEDEFOP	European Centre for the Development of Vocational Training
EQF	European Qualifications Framework
ISCO	International Classification of Occupations
SESCOs	National and local skills ecosystem coordinators
SpiderCOs	Spider Coordinators
UCLL	University College Leuven-Limburg
ULOs	Units of Learning Outcomes

1.Introduction

1.1 *Context of the P4ELECS project*

Technological innovation in the energy and mobility sectors is evolving rapidly. Developments such as photovoltaic systems, smart grids, electric mobility, and intelligent energy management systems require new competences across a wide range of professional roles. However, education and training systems often struggle to keep pace with these developments. As a result, gaps emerge between the skills required by industry and the competences currently available in the workforce.

The ERASMUS+ project **P4ELECS (Platforms for Partnerships for Excellence in Electric Systems)** aims to strengthen Centres of Vocational Excellence by improving collaboration between education, research, and industry in the electrical and energy domains. A key objective of the project is to support education and training providers in responding more effectively to technological innovation by developing flexible and modular learning content aligned with labour market needs.

Within this context, identifying emerging skill needs and translating them into educational content is essential. This requires structured methods that enable stakeholders to analyse technological developments, identify affected occupations, and translate these insights into learning outcomes that can be integrated into education and training programmes.

1.1 *Context of the P4ELECS project*

Work Package 2 (WP2) of the P4ELECS project focuses on the development of quality guidelines for Building Blocks (BBs) and courses. Building Blocks represent modular educational components that can be combined into short courses, training programmes, and micro-credentials.

A key element in the development of these Building Blocks is the definition of Units of Learning Outcomes (ULOs). ULOs describe the knowledge, skills, and attitudes that learners are expected to acquire and demonstrate after completing a learning unit. To ensure that these learning outcomes reflect real labour market needs, they must be based on a systematic analysis of skill requirements related to emerging technologies.

Task T2.3 – Skills mapping for the topics of the CDIO spiders and development of Units of Learning Outcomes therefore focuses on identifying the skill needs associated with the innovations addressed within the P4ELECS project. This task involves collaboration between education providers, industry representatives, and research organisations to map relevant occupations, analyse emerging tasks and responsibilities, and translate these insights into Units of Learning Outcomes.

1.3 Objective of Deliverable D2.2

This report presents Deliverable D2.2 – Model for Skills Intelligence, developed within Work Package 2 and led by ISSO. This deliverable contributes to Task T2.3 of Work Package 2, which focuses on skills mapping and the development of Units of Learning Outcomes based on identified skill needs.

The objective of this deliverable is to provide guidelines and a structured methodology for identifying skill needs within the skills ecosystem and translating these needs into Units of Learning Outcomes (ULOs). The methodology supports the alignment between technological innovation, labour market demands, and the development of educational content.

The report introduces the ISSO Skills Intelligence Model, which provides a systematic approach for:

- analysing technological innovations and their potential impact on occupations;
- identifying the competences required by professionals working with these innovations;
- mapping tasks and responsibilities associated with relevant occupations;

- validating the identified skill needs through expert consultation with representatives from education, industry, and research;
- translating the identified skill needs into structured Units of Learning Outcomes.

The resulting ULOs form the basis for the development of Building Blocks (BBs) and courses within the P4ELECS project, enabling modular and flexible learning pathways aligned with European qualification frameworks.

The overall structure of the ISSO Skills Intelligence Model is illustrated in Figure 1. The model describes the process through which technological innovation is translated into identified skill needs and subsequently into Units of Learning Outcomes that support the development of Building Blocks and courses

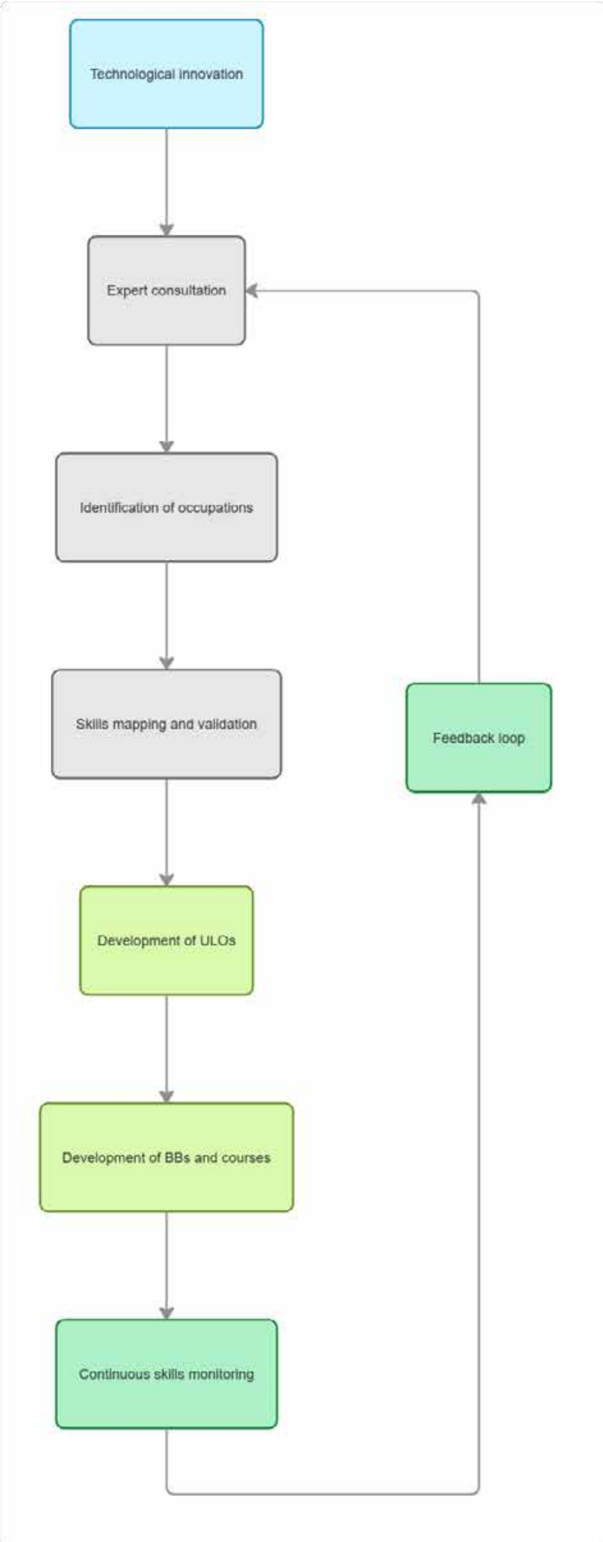

Figure 1Framework of the ISSO Skills Intelligence Model

The model illustrates how technological innovation is analysed and translated into emerging skill needs through expert consultation and skills mapping. These insights are subsequently converted into Units of Learning Outcomes (ULOs), which support the development of Building Blocks and courses. Continuous monitoring enables periodic updates of skills and educational content. The model provides a repeatable methodology that can be applied across different innovation domains.

1.3 Objective of Deliverable D2.2

The remainder of this report is structured as follows:

Section 2 introduces the ISSO Skills Intelligence Model and its conceptual foundations.
Section 3 describes the methodology used for skills mapping and the identification of relevant occupations, tasks, and responsibilities.
Section 4 explains how the identified tasks are translated into Units of Learning Outcomes in accordance with European guidelines.
Section 5 presents the outcomes of the skills needs analysis and the lessons learned during the implementation within the P4ELECS project.
Section 6 concludes the report with recommendations for the further implementation and scaling of the Skills Intelligence Model within regional and European skills ecosystems.

2. The ISSO Skills Intelligence Model

ISSO Skills Intelligence Model follows a structured process that translates technological innovation into clearly defined skill needs and educational outcomes The methodology consists of six main steps:

1. Monitoring technological innovation (TRL 4-6)
2. Expert consultation involving representatives from education, industry and research
3. Identification of relevant occupations and EQF levels
4. Skills mapping based on tasks and responsibilities
5. Validation of the identified tasks and responsibilities
6. Translations of identified skill needs into Units of Learning Outcomes (ULOs)

The resulting ULOs form the basis for the development of Building Blocks (BBs) and courses within the P4Elecs project.

2.1 Overview of the model and its application in P4ELECS

The ISSO Skills Intelligence Model was developed to bridge the gap between technological innovation and the development of the skills needed for widespread adoption. The theoretical foundation of the model builds on the work of Hekkert and Suurs [1], who, through their innovation curves and functions of innovation systems, provide a framework for understanding the dynamics of technological change.

The innovation curve of Hekkert and Suurs

Innovations typically follow a recognizable cycle:

- Innovators experiment and take risks to test new technologies.
- Early adopters gain the first practical experiences and solve many of the initial obstacles.
- Early majority joins only once the technology has proven itself and scaling up is required.
- Late majority and laggards adopt the technology once it has become fully established.

ISSO's experience shows that the phase of innovators and early adopters is particularly important. Early adopters often willingly share their knowledge and experiences, since they quickly shift their focus to the next innovation. Their insights reveal which skills will be required on a larger scale at later stages of adoption.

TRL levels and the ISSO model

The model links this innovation curve to Technology Readiness Levels (TRLs):

- TRL 1–3 (Discovery): fundamental research and proof of concept. At this stage there is not yet sufficient practical applicability.
- TRL 4–6 (Development): prototypes are validated in relevant environments and practical experience emerges. This is the stage at which the ISSO Skills Intelligence Model is applied.
- TRL 7–9 (Demonstration & Deployment): technologies are demonstrated in operational environments and broadly introduced to the market. At this stage, demand for skills becomes urgent and training programmes are scaled up.

ISSO's choices

The ISSO Skills Intelligence Model deliberately begins at TRL 4–6. At this point, key problems have been solved, the technology has stabilized, and reliable practical knowledge is available. By systematically engaging with innovators and early adopters, the model can predict the skill gaps that will emerge when the early majority becomes involved. This enables training providers and policymakers to adjust programmes in time and to plan investments and projects accordingly.

Learning Outcomes and ULOs

A central element of the model is the translation of Learning Outcomes (LOs) into Units of Learning Outcomes (ULOs):

- Learning Outcomes describe what a student or professional must know, understand and be able to do.
- ULOs translate these outcomes into concrete and assessable units.
- Developers of Building Blocks (BBs) use ULOs as the foundation for modular curricula and training materials.
- Based on the ULOs, developers can determine whether intended objectives are achieved, or whether certain learning outcomes should be deliberately excluded or adjusted.
- This approach makes it possible to tailor learning outcomes to different EQF levels, depending on the target group and the specific innovation.
- Connection with European frameworks

The ISSO Skills Intelligence Model is embedded within the European context:

- The European Qualifications Framework (EQF) ensures that learning outcomes are transparent and comparable across countries and levels.
- The guidelines of CEDEFOP promote consistency and transparency in vocational education and training across Europe.
- The ESCO database (European Skills, Competences, Qualifications and Occupations) links occupations to responsibilities, competences, and EQF levels. By using ESCO, the model directly connects innovations to the labour market and identifies which competences are required for specific professions.

2.2 The Skills Intelligence Model in P4ELECS

The P4ELECS project applied the ISSO Skills Intelligence Model to innovations in the energy and mobility sectors. This application demonstrated how the theoretical principles of the model can be put into practice.

Innovation topics in P4ELECS

The innovations were predefined in the project proposal and further elaborated during implementation. They included:

- photovoltaic systems (PV)
- wind energy
- smart homes and smart grids
- charging infrastructure for electric vehicles and e-bikes
- (H)EV drivetrains
- public lighting

Composition of expert groups

During the project, different configurations of expert groups were tested. The most valuable mix included representatives of:

- education (curricula and didactics),
- manufacturers (technological developments),
- sector organisations (industry-wide insights),
- practitioners and operators (experience with applying technology in practice).

This broad mix ensured that both fundamental knowledge and practical experience were incorporated into the analysis.

From higher EQF levels to educational practice

At EQF level 6 and above, knowledge is often more fundamental and experimental in nature. In P4ELECS, this knowledge was combined with practical expertise from industry and translated into Learning Outcomes and ULOs that could be applied at multiple EQF levels. Developers of Building Blocks then used these ULOs to design modular training materials aligned with sectoral needs. This allowed them to decide whether objectives were fully achieved, or whether certain learning outcomes would deliberately be excluded or adapted.

Linking innovations, occupations and gap analysis

The application of the model enabled systematic linking of innovations to occupations. This made it possible to identify which skills are currently missing and where the most critical skill gaps are located. At this stage, this represents an initial gap analysis: it becomes clear which competences are lacking and which occupations are most affected. The detailed content of these gaps is elaborated in a later phase, when they are translated into ULOs and Building Blocks.

Example– Smart Grids

For the innovation smart grids, occupations such as installers, electrical technicians and engineers were identified as most affected. These professions will require new competences in areas such as data use, system integration and cybersecurity. The model highlights that these competences are currently missing in the workforce. The exact content of the gap—for example, the level of knowledge on data security that an installer must possess—will only become clear once the gaps are further developed into ULOs.

The following section describes the skills mapping methodology in detail and explains how occupations, tasks and responsibilities were identified and validated within the P4ELECS project.

3. Skills Mapping

Following the conceptual foundation of Hekkert and Suurs laid out in the previous section, this section focuses on translating the ISSO *Skills Intelligence Model* into *targeted skills mapping*. While the model of Hekkers and Suurs outlines *when* and *why* educational content should align with innovation dynamics, skills mapping addresses the critical questions of *what* skills, *who* needs them, and at *what* level. Conducted in close collaboration with domain experts, this process ensures that identified skill needs are grounded in real-world contexts and accurately reflect the demands of evolving occupations. By bridging the gap between innovation analysis and curriculum design, skills mapping serves as a crucial step in developing adaptive, future-ready training programs.

3.1 Occupations and EQF Levels

The first step in skills mapping was to establish the group of experts to identify the relevant occupations for each innovation topic and assign the appropriate European Qualifications Framework (EQF) level to each occupation. Expert discussion sessions, organised by SpiderCos and supported by ISSO, focused on:

- Identifying which occupations are directly affected by the innovation.
- Determining which EQF levels reflect the increasing complexity of these tasks.

A Preparatory arrangements form (Figure 1) was used to collect the data. The form capturated the composition of the expert group, the relevant occupation(s) and EQF levels associated with the innovation, as well as the dates on which the expert discussions were held.

Preparatory arrangements form

Spider topic:	
SpiderCo:	

1. Confirm your group of experts:

Experts	Name:	Role:	e-mail:
Someone from VETs (i.e someone who creates training programs for)			
Someone from industry (i.e someone who works with the product of or an employer in the sector)			
Someone from research (i.e. someone from the association of, or an employer in the sector)			

2. Confirm with your expert group the occupations and its EQF level directly related to the spider topic:

Occupations:	EQF level:
Select an item.	Select an item.
Select an item.	Select an item.
Select an item.	Select an item.
Select an item.	Select an item.
Select an item.	Select an item.
Select an item.	Select an item.

Note that this is a list of occupations suggested by ISSO experts based on the ESCO database. If your occupations are not listed, you can search for it here.

3. Establish two dates with your experts to discuss the results of your skill needs analysis and to develop your ULOS:

Skill needs analysis					ULOS development				
Monday 13/01 10:00-12:00 OR 13:00-15:00	Tuesday 14/01 10:00-12:00 OR 13:00-15:00	Wednesday 15/01 10:00-12:00 OR 13:00-15:00	Thursday 16/01 10:00-12:00 OR 13:00-15:00	Friday 17/01 10:00-12:00 OR 13:00-15:00	Monday 03/02 10:00-12:00 OR 13:00-15:00	Tuesday 04/02 10:00-12:00 OR 13:00-15:00	Wednesday 05/02 10:00-12:00 OR 13:00-15:00	Thursday 06/02 10:00-12:00 OR 13:00-15:00	Friday 07/02 10:00-12:00 OR 13:00-15:00

Figure 2 Preparatory arrangements form

3.2 Identifying Tasks, responsibilities and skill levels

Once occupations and corresponding EQF levels had been established, ISSO applied the ULO Generator.

This tool automatically retrieved:

- Occupational titles and codes according to the ESCO classification;
- Descriptions of tasks and responsibilities;
- Required skill levels;
- An initial draft of ULOs.

The retrieved data was then organized into a template that consolidated all relevant information. This included the innovation topic, the occupation (with a direct link to the ESCO database), the EQF level (previously defined by SpiderCo and the expert group), the tasks and responsibilities associated with the occupation, and a first draft of the corresponding ULOs (knowledge, skills, and attitudes). Figure 2 presents an example of the output data.

Low voltage DC

Occupation: Electrical engineer	EQF Level: 7	ULOS (Units of Learning Outcomes)		
Tasks and responsibilities:	**Level of competence:**	**Knowledge**	**Skills**	**Attitude**
(a) The electrical engineer advises on and designs power stations and systems which generate, transmit, and distribute electrical power.	4,5	The electrical engineer can advise on power stations and systems which generate, transmit and distribute electrical power. The electrical engineer can design power stations and systems which generate, transmit and distribute electrical power		
(b) The electrical engineer supervises, controls, and monitors the operation of electrical generation, transmission, and distribution systems.	2, 3	The electrical engineer can monitor the operation of electrical generation, transmission and distribution systems	The electrical engineer can supervise the operation of electrical generation, transmission and distribution systems The electrical engineer can manage the operation of electrical generation, transmission and distribution systems	
(c) The electrical engineer advises on and designs systems for electrical motors, electrical traction, and other equipment, or electrical domestic appliances.	4,5	The electrical engineer can advise on systems for electrical motors, electrical traction and other equipment, or electrical domestic appliances. The electrical engineer can design systems for electrical motors, electrical traction and other equipment, or electrical domestic appliances		
(d) The electrical engineer specifies electrical installation and application in industrial and other buildings and objects.	3	The electrical engineer can specify electrical installation and application in industrial and other buildings and objects		
(e) The electrical engineer establishes control standards and procedures to monitor performance and safety of electrical generating and distribution systems, motors, and equipment.	4	The electrical engineer can establish control standards and procedures to monitor performance and safety of electrical generating and distribution systems, motors and equipment		
(f) The electrical engineer determines manufacturing methods for electrical systems, as well as maintenance and repair of existing electrical systems, motors, and equipment.	4	The electrical engineer can establish manufacturing methods for electrical systems, as well as maintenance and repair of existing electrical systems, motors and equipment		

**Note that the levels of competence were determined on the basis of the verbs used. CEDEFOP provided a list of precise action verbs and we have classified them according to Bloom's Taxonomy (for example, there are verbs that are more appropriate to describe knowledge, skill or attitude). You can see here the classification.*

Figure 3 Example of the resulted data

> **Remark**
>
> Importantly, the automatic results were treated as a baseline only.

3.4 Validating Tasks, responsibilities and skill levels

In subsequent expert-led sessions, the generated tasks and responsibilities and associated skill levels (Figure 4) were critically reviewed to ensure both relevance and completeness.

Level	Competence	Task characteristics	Characterization of a person as:
1	Remember & understanding	Simplicity, routine, repetition	Conversation partner, interested party, learner
2	Apply	Apply routine, appropriate standards and practices	Novice professional / craftsman, working under supervision
3	Analysis & problem solving	Less routine, experience required, problem analysis and solution	Experienced professional / craftsman, works independently
4	Evaluate	Complex, non-standard, requires insight, experience, and decision-making skills	Front-runner, expert, assessor, mastery, service specialist
5	Create	Unique, innovative, never done before, integration of knowledge and skills from multiple domains	Innovator, instructor

Figure 4 Skill levels

The information was presented and circulated to each SpiderCo for feedback. SpiderCos facilitated validation discussions with their experts. Expert groups carefully reviewed each task, asking:

- Does this task still reflect actual professional practice?
- Are any outdated or irrelevant tasks included?
- What new or emerging tasks should be added?
- Is it the skill level appropriate for each task?

This ensured that the mapping was not static, but a living reflection of practice under technological change.

The discussions included three main perspectives:

- Education experts – linking outcomes to curriculum design.
- Industry professionals – bringing in applied experience and operational challenges.
- Research representatives – identifying emerging skills from new technologies.

This triangulation allowed both vertical alignment (skills at different EQF levels) and horizontal alignment (skills across related occupations).

4. Development of ULOs

With validated tasks and responsibilities and its skill levels in place, the next step in the ISSO methodology was the development of ULOs. This section outlines how identified skills were refined into structured, actionable learning outcomes that meet European quality standards and support modular curriculum design.

4.1 Refinement of tasks into ULOs

Using the outcomes of the skills mapping process, tasks were deconstructed into three core components—*knowledge, skills, and attitudes*—to formulate comprehensive ULOs for each occupation. Same template (Figure 5) was employed to organise the information from expert consultations and present a set of proposed ULOs for each Spider topic.

New tasks and responsibilities for future Electrical Engineers in Low Voltage DC (LVDC):				
New tasks and responsibilities:	**Level of competence:**	**Knowledge**	**Skills**	**Attitude**
g) The electrical engineer **integrates and configures** digital **communication protocols** such as IEC 61850, Modbus, and TCP/IP for seamless operation of DC power networks, ensuring interoperability between electrical components and control systems. They also use simulations to optimize and test LVDC network designs.	3	The electrical engineer **identifies** the characteristics and functions of digital communication protocols such as IEC 61850, Modbus, and TCP/IP in DC power networks to ensure interoperability between electrical components and control systems.	The electrical engineer **configures and integrates** communication protocols such as IEC 61850, Modbus, and TCP/IP in DC power networks to enable interoperability between electrical components and control systems. The electrical engineer **applies** simulation and modeling techniques to predict the behavior of LVDC networks, optimize design choices, and evaluate system resilience under varying loads and operational conditions.	The electrical engineer **ensures** compliance with communication protocol standards to guarantee seamless operation of DC power networks.
h) The electrical engineer **develops and configures** software-driven electrical systems for real-time monitoring, diagnostics, and optimization of low voltage DC systems, ensuring seamless operation of power electronics, energy storage systems, and smart grid infrastructure through embedded programming and system integration.	3	The electrical engineer **identifies** key software-driven electrical systems used for real-time monitoring, diagnostics, and optimization of low voltage DC systems to ensure seamless operation of systems, through embedded programming and system integration	The electrical engineer **develops and configures** software-driven electrical systems used for real-time monitoring, diagnostics, and optimization of low voltage DC systems to ensure seamless operation of power electronics, energy storage systems, and smart grid infrastructure through embedded programming and system integration.	The electrical engineer **supports** continuous improvement and technological innovation in software-driven electrical system monitoring and diagnostics to ensure seamless operation of systems, through embedded programming and system integration.
i) The electrical engineer **designs and integrates** low voltage DC systems, including renewable energy systems, battery storage, and electric vehicle (EV) charging stations, ensuring compatibility with AC systems and optimizing efficiency.	5	The electrical engineer **explains** the principles of low voltage DC systems, including renewable energy systems, battery storage, and electric vehicle (EV) charging stations, and their integration with AC systems to optimize efficiency.	The electrical engineer **designs and integrates** low voltage DC systems, selecting appropriate components for renewable energy systems, battery storage, and EV charging stations.	The electrical engineer **follows** industry best practices and standards when integrating low voltage DC systems with AC networks.
j) The electrical engineer **designs and implements** advanced control and protection strategies for low voltage DC systems, addressing issues such as fault detection, arc flash safety, and fault current protection, in compliance with industry standards.	5	The electrical engineer **describes** advanced control and protection strategies for low voltage DC systems, including fault detection, arc flash safety, and fault current protection.	The electrical engineer **implements** advanced control and protection strategies, configuring systems to detect and mitigate faults in compliance with industry standards.	The electrical engineer **ensures** adherence to safety regulations and best practices in designing protection strategies for low voltage DC systems.
k) The electrical engineer **ensures** system-level integration of Low Voltage DC components, including power conversion, automation, and industrial control systems, optimizing performance and efficiency for industrial and commercial applications.	4	The electrical engineer **explains** the principles of system-level integration of Low Voltage DC components, including power conversion, automation, and industrial control systems to optimize system performance.	The electrical engineer **applies** techniques to optimize the performance and efficiency of industrial and commercial LVDC applications.	The electrical engineer **demonstrates** a commitment to ensuring seamless integration of LVDC components for enhanced system performance.

Figure 5 Example of new tasks and ULOs

Refinement was an iterative process supported by continued collaboration. Follow-up sessions, organized either by ISSO or independently by the SpiderCos and their expert group, were instrumental in reviewing and enhancing the proposed ULOs. The feedback from these discussions ensured that the ULOs were both practically relevant and feasible to implement.

Each ULO was crafted following CEDEFOP[2] recommended syntax for short, learning-outcomes-based descriptions:

Learning-outcomes-based syntax:

[Subject + Action Verb + Object + Context

To ensure alignment with European standards the *action verbs* were selected from the CEDEFOP reference list and cross-referenced with *Bloom's Taxonomy[3] (Figure 6)*. This approach guaranteed a clear distinction between cognitive (knowledge), practical (skills), and affective (attitudes) learning dimensions.

Verbs to describe knowledge

KNOWLEDGE		
Skill Levels	**Levels**	**Precise action verbs**
Remember & understand	Remember	acquire, allocate, check, describe, identify, learn, list, look up, observe, receive, recite, recognise, repeat, reproduce, return, select, store
	Understand	count, distinguish, document, estimate, explain, interpret, search, summarize
Apply	Apply	administer, adopt, apply, assure, choose, collect, construct, demonstrate, expose, extract, find, include, indicate, inform, maintain, modify, monitor, optimise, organise, prepare, produce, relate, remedy, sell, serve, sketch, solve
Analysis & problem solving	Analyze	analyse, calculate, compare, conclude, contrast, differentiate, distinguish, examine, Identify, prevent, program, reflect, relate, research, resolve, select, specify
Evaluate	Evaluate	advise, anticipate, assess, compare, critique, elaborate, establish, evaluate, improve, instruct, judge, oversee, protect, refine, relate, restore, specify, standardise, summarize, support, take stock, validate
Create	Create	combine, compile, conceptualise, construct, create, design, develop, draft, explain, manufacture, modify, organise, plan, produce, relate, reorganise, revise, shape, specify, structure, summarize, visualise, write

Verbs to describe skills

SKILLS		
Skill Levels	**Levels**	**Precise action verbs**
Remember & understand	Perceive	choose, describe, detect, differentiate, distinguish, Identify, relate, select
	Set	count, distinguish, document, estimate, explain, interpret, search, summarize
Apply	Guided response or imitate	employ, follow, react, replace, reproduce, run, sell, supply, execute
	Mechanism or repeat / reproduce	adjust, assemble, calibrate, comply with, construct, consult, correct, dismantle, dismount, divide, draw, exchange, handle, implement, insert, measure, mount, organise, place, process, repair, set up, sketch, stake out, test, transfer
Analysis & problem solving	Complex over response or self-perform / demonstrate	accomplish, adjust, assemble, build, calibrate, commission, communicate, conduct, connect, consolidate, construct, coordinate, decide, delegate, deliver, diagnose, direct, disassemble, dismantle, disseminate, enforce, experiment, explore, follow up, fulfil, guide, install, manage, master, measure, organise, renovate, sketch, supervise
Evaluate	Adaptation or perform / customise (in context)	adapt, assess, configure, eliminate, ensure, lead, rebuild, rehabilitate, reorganise, revise, transform, update
Create	Origination or automatic/unconscious execution	build, combine, construct, create, design, initiate

Verbs to describe attitude

ATTITUDE		
Skill levels	**Levels**	**Precise action verbs**
Remember & understand	Awareness, willingness to	describe, follow, identify, select, choose

Apply	Responding to phenomena	accompany, assist, introduce, look after, meet, obtain, present, read, recite, report, respond, select
Analysis & problem solving	Value	accept, complete, cooperate, demonstrate, explain, follow, guide, initiate, justify, limit, mobilise, participate, prepare, promote, propose, read, report, respect, select, share, take part, undertake
Evaluate	Organise	approve, collaborate, combine, compare, complete, explain, formulate, identify, integrate, involve, modify, organise, realise, relate, synthesise
Create	Characterise/ internalize	intervene, modify, negotiate, propose, revise, self-evaluate, solve, verify

Figure 6 List of precise action verbs crossed with Bloom's taxonomy

Example of resulted ULO

Knowledge:

The electrical engineer identifies the characteristics and functions of digital communication protocols to ensure interoperability between electrical components and control systems.

Skills:

The electrical engineer configures and integrates communication protocols in DC power networks to enable interoperability between electrical components and control systems.

Attitude:

The electrical engineer proactively ensures compliance with communication protocol standards to guarantee seamless operation of DC power networks.

4.2 Compilation and integration of information

After refining the tasks and ULOs, each SpiderCo received a comprehensive summary report that included:

- A synthesis of expert feedback, insights, and final agreements reached during consultation sessions (Figure 7);
- An overview of the newly identified skill needs and their corresponding proposed ULOs (Figure 8);
- A validation section for formal expert review and approval (Figure 9).

This structure facilitated clear documentation, supported accountability, and provided a robust basis for future updates.

Final documents are provided as part of the Appendix.

Skill needs analysis & expert agreement

This document outlines the identified skill needs for the Spider topic of **Low voltage DC** for the P4ELECS project, based on expert consultation. It includes the analysis, expert feedback, and final agreements, with a signature section for validation.

- Data collection method: Interviews and discussions
- Number of experts consulted: 5
- Date of consultation: 20-2-2025 & 27-3-2025

Expert comments & agreements

Below is a summary of expert feedback and their agreements on the skill needs analysis:

Participants agree that an Electrical engineer should have a **solid understanding of the electrical grid and systems**, with some suggesting that electrical engineers should also focus **on ICT** (information and communication technologies), such as **energy management** and **communication protocols.**

Key points discussed include:

- **Basic skills and knowledge**: Engineers need a fundamental understanding of **energy generation, transmission, distribution, storage, and consumption**.
- **Role of software and ICT**: There was a growing consensus that electrical engineers today must have basic knowledge of **ICT, as many systems communicate electronically, requiring an understanding of control software, optimization, and system integration.**
- **Practical experience**: It was emphasized that fresh graduates often lack practical hands-on experience, such as working with electrical components or using tools like RTUs (remote terminal units).

Figure 7 Example of a comprehensive summary report

Low voltage DC

Occupation:	Electrical engineer	EQF Level: 7	ULOS (Units of Learning Outcomes)		
Tasks and responsibilities:		**Level of competence:**	**Knowledge**	**Skills**	**Attitude**
(a)	The electrical engineer **connects and adjusts** *digital communication protocols, for seamless operation of DC power networks*, ensuring interoperability between electrical components and control systems. They also use simulations to optimize and test LVDC network designs.	3	The electrical engineer **specifies** *the characteristics and functions of digital communication protocols in DC power networks* to ensure interoperability between electrical components and control systems.	The electrical engineer **connects and adjusts** *communication protocols in DC power networks* to enable interoperability between electrical components and control systems. The electrical engineer **conducts** *simulation and modeling techniques* to measure the behavior of LVDC networks, guide design choices, and explore system resilience under varying loads and operational conditions.	The electrical engineer **promotes** *compliance with communication protocol standards* to guarantee seamless operation of DC power networks.
(b)	The electrical engineer **installs and connects** *software-driven electrical systems for real-time monitoring of low voltage DC systems*, ensuring seamless operation of power electronics, energy storage systems, and smart grid infrastructure through embedded programming and system integration.	3	The electrical engineer **specifies** *key software-driven electrical systems used for real-time monitoring of low voltage DC systems* to ensure seamless operation of systems, through embedded programming and system integration	The electrical engineer **installs and connects** *software-driven electrical systems used for real-time monitoring of low voltage DC systems* to ensure seamless operation of power electronics, energy storage systems, and smart grid infrastructure through embedded programming and system integration.	The electrical engineer **promotes** *continuous improvement and technological innovation in software-driven electrical system monitoring* to ensure seamless operation of systems, through embedded programming and system integration.
(c)	The electrical engineer **designs and integrates** *low voltage DC systems, including renewable energy systems*, ensuring compatibility with AC systems and optimizing efficiency.	5	The electrical engineer **explains** *the principles of low voltage DC systems, including renewable energy systems*, and their integration with AC systems to optimize efficiency.	The electrical engineer **designs and integrates** *low voltage DC systems*, selecting appropriate components for renewable energy systems.	The electrical engineer **follows** *industry best practices and standards* when integrating low voltage DC systems with AC networks.
(d)	The electrical engineer **designs** *advanced control and protection strategies for low voltage DC systems*, addressing issues such as fault detection, arc flash safety, and fault current protection, in compliance with industry	5	The electrical engineer **conceptualizes** *advanced control and protection strategies for low voltage DC systems*, including fault detection, arc flash safety, and fault current protection.	The electrical engineer **designs** *advanced control and protection strategies*, configuring systems to detect and mitigate faults in compliance with industry standards.	The electrical engineer **ensures** *adherence to safety regulations and best practices* in designing protection strategies for low voltage DC systems.

Figure 8 Skill needs analysis report for Low voltage DC

P4ELECS Platform for Electrification Skills & Competences

ISSO

Final approval & signatures

The undersigned confirm their review and agreement with the skill needs analysis as presented.

Name	Position	Organization	Signature	Date
Annick Dexters	[Position]	[Organization]	[Signature]	[Date]
Laurens Mackay	[Position]	[Organization]	[Signature]	[Date]
Henry Lootens	[Position]	[Organization]	[Signature]	[Date]
Giel van de Broeck	[Position]	[Organization]	[Signature]	[Date]
Simon Ravyts	[Position]	[Organization]	[Signature]	[Date]

Figure 9 Validation section example

5 Outcomes and impacts

5.1 Lessons from P4ELECS

The experiences in P4ELECS revealed that:

- Innovations at TRL 4–6 are the most suitable for identifying future skill needs, as sufficient practical experience is available.
- Early adopters are a crucial source of information, since they are willing to share their experiences before moving on to the next innovation.
- By combining knowledge from higher education with industry practice, Learning Outcomes can effectively be translated across multiple EQF levels.
- Strengthening EQF level 5 is particularly important, since this level remains underdeveloped in many EU countries, while demand for well-trained professionals at this level is high.
- A multidisciplinary approach involving education, manufacturers, sector organisations and practitioners produces the most reliable and useful results

5.2 Insights from the Skills Needs Analysis

Despite some logistical challenges—particularly in bringing together expert groups simultaneously—Spider Coordinators successfully adapted by conducting individual interviews and follow-up consultations. These efforts enriched the review process and surfaced critical observations, including:

- **Task granularity:** Some identified tasks were initially too broad or vague. These were refined, replaced, or removed to ensure clarity and precision, recognizing that this remains an ongoing process that requires continuous attention
- **Occupation-level differentiation:** Distinguishing between occupations and corresponding EQF levels proved complex but was effectively resolved through expert dialogue.
- **Varied Skill Gaps:** While certain topics revealed missing foundational skills, others required the inclusion of logical reasoning and problem-solving skills, current development in AI and robotics.
- **Process integration challenges:** Establishing the Skills Intelligence Model and communicating its framework effectively to expert groups presented early obstacles. However, these were progressively overcome through iterative engagement and clearer guidance.

These insights played a pivotal role in refining the process, improving expert collaboration, and enhancing the quality of outcomes.

5.3 High-quality task-based ULOs

The refined understanding of skills needs directly informed the development of ULOs. These ULOs articulate what learners must know, understand, and be able to do—integrating knowledge, skills, and attitudes in a way that is immediately applicable to real-world job roles.

The ULOs serve as foundational components for:

- **Designing Building Blocks (BBs):** Shaping modular learning units that reflect practical skill demands.
- **Course Development:** Supporting dynamic and responsive training program structures.
- **Curricular Flexibility:** Enabling tailored learning paths through micro-credentials and modular certifications.

6 Conclusions and recommendations

The collaborative effort among Spider Coordinators, domain experts, UCLL, and ISSO has been central to the successful implementation of the ISSO Skills Intelligence Model. Through an integrated skills mapping process, stakeholders effectively identified current and emerging skill needs tied to technological innovation.

The ISSO Skills Intelligence Model is designed as a tranferable methodology that can be applied in different technological domains and regional skills ecosystems. By combining innovation monitoring, expert consultation and structured skills mapping, the model enables stakeholders to systematically translate technological developments into educational outcomes. This approach can therefore be replicated by other sectors seeking to align training and workforce development with emerging technologies.

By assessing both existing competencies and identified gaps, SpiderCos played a key role in ensuring that relevant and up-to-date skill profiles were defined for each Spider topic. These insights directly informed the development of ULOs, concrete, measurable outcomes that articulate what learners must know, understand, and be able to do.

The ULOs now serve as the foundation for the (re)design of Building Blocks (BBs) and course structures. This ensures that educational programs are not only aligned with labour market demands but also responsive to changes in innovation dynamics. The model promotes a *data-driven and iterative approach* to curriculum development—one that is built on real-world insights, stakeholder collaboration, and scalable implementation strategies.

By embedding Skills intelligence into the curriculum design process, P4ELECS demonstrates a replicable and transferable framework for future-proofing education systems across Europe.

Recommendations for Implementation

To ensure continued success and scalability of the model, the following recommendations are proposed:

- **Map ULOs to BBs:** Clearly link each ULO to specific BBs to guide modular course design, ensuring that training is structured, coherent, and aligned with occupational profiles.
- **Institutionalize the Model in Local Skills Ecosystems:** The Skills Intelligence Model could be established as a core component of the future P4ELECS Skills Ecosystem. While it is currently being piloted in five regional ecosystems, it holds strong potential for expansion and adoption across broader European contexts.
- **Enable on-going Skills monitoring:** Use the model as a dynamic tool for the *continuous identification and validation of emerging skills*. This should be supported by periodic skills needs analyses and expert consultations.
- **Promote flexibility through Micro-Credentials:** Leverage the model's modular structure to support the *creation of micro-credentials, stackable BBs, and full course programs*, allowing learners to navigate diverse learning pathways and adapt to evolving job market demands.

By integrating real-time data, stakeholder expertise, and innovation foresight, the P4ELECS initiative sets a strong precedent for responsive, high-impact education in Europe's fast-changing technical sectors. The methodology developed here is not only a tool for today's training needs, but a strategic asset for the workforce challenges of tomorrow.

7 Annexes

7.1 Templates

A.1 - Preparatory arrangements form

Spider topic:	
SpiderCo:	

4. Confirm your group of experts:

Experts	**Name:**	**Role:**	**e-mail:**
Someone from VETs (i.e someone who creates training programs for)			
Someone from industry (i.e someone who works with the product of or an employer in the sector)			
Someone from research (i.e. someone from the association of, or an employer in the sector)			

5. Confirm with your expert group the occupations and its EQF level directly related to the spider topic:

Occupations:	EQF level:
Kies een item.	Kies een item.
Kies een item.	Kies een item.
Kies een item.	Kies een item.
Kies een item.	Kies een item.
Kies een item.	Kies een item.
Kies een item.	Kies een item.

Note that this is a list of occupations suggested by ISSO experts based on the ESCO database. If your occupations are not listed, you can search for it here.

6. Establish two dates with your experts to discuss the results of your skill needs analysis and to develop your ULOS:

Skill needs analysis					ULOS development				
Monday 13/01 10:00-12:00 OR 13:00-15:00	Tuesday 14/01 10:00-12:00 OR 13:00-15:00	Wednesday 15/01 10:00-12:00 OR 13:00-15:00	Thursday 16/01 10:00-12:00 OR 13:00-15:00	Friday 17/01 10:00-12:00 OR 13:00-15:00	Monday 03/02 10:00-12:00 OR 13:00-15:00	Tuesday 04/02 10:00-12:00 OR 13:00-15:00	Wednesday 05/02 10:00-12:00 OR 13:00-15:00	Thursday 06/02 10:00-12:00 OR 13:00-15:00	Friday 07/02 10:00-12:00 OR 13:00-15:00

A.2 - Template to Map Skill Needs and develop ULOs

Occupation:		**EQF Level:**		**ULOS**		
Tasks and responsibilities:		Level of competence:		Knowledge	Skills	Attitude
a) -		-		-	-	-
b) -		-		-	-	-
c) -		-		-	-	-
d) -		-		-	-	-
e) -		-		-	-	-
f) -		-		-	-	-

Levels of competence:

Level	Competence	Task characteristics	Characterisation of a person as:
1	Remember & understanding	Simplicity, routine, repetition	Conversation partner, interested party, learner
2	Apply	Apply routine, appropriate standards and practices	Novice professional / craftsman, working under supervision
3	Analysis & problem solving	Less routine, experience required, problem analysis and solution	Experienced professional / craftsman, works independently
4	Evaluate	Complex, non-standard, requires insight, experience, and decision-making skills	Front-runner, expert, assessor, mastery, service specialist
5	Create	Unique, innovative, never done before, integration of knowledge and skills from multiple domains	Innovator, instructor

A.3 - Questions to guide the identification of skills needs

Validate tasks and responsibilities

1. How well do the listed tasks and responsibilities align with *the occupation/profession* day-to-day duties? Are there any key differences or gaps?
2. Could you identify any additional tasks that *the professionals* regularly perform that are not listed in your official role description?
3. *Discuss impact of innovations*
4. How have these innovations affected *the current tasks* and responsibilities of professionals? Do they make certain tasks easier or more difficult?
5. Have these innovations required *the professional* to learn new skills or adapt his approach to certain tasks? If yes, how did they go about this?
6. *Identify new tasks and analyze the reason behind the gap*

7.2 Annex B - Matrix of precise action verbs aligned with Bloom's taxonomy

B1 - Verbs to describe knowledge

KNOWLEDGE		
Skill Levels	**Levels**	**Precise action verbs**
Remember & understand	Remember	acquire, allocate, check, describe, identify, learn, list, look up, observe, receive, recite, recognise, repeat, reproduce, return, select, store
	Understand	count, distinguish, document, estimate, explain, interpret, search, summarize
Apply	Apply	administer, adopt, apply, assure, choose, collect, construct, demonstrate, expose, extract, find, include, indicate, inform, maintain, modify, monitor, optimise, organise, prepare, produce, relate, remedy, sell, serve, sketch, solve
Analysis & problem solving	Analyze	analyse, calculate, compare, conclude, contrast, differentiate, distinguish, examine, Identify, prevent, program, reflect, relate, research, resolve, select, specify
Evaluate	Evaluate	advise, anticipate, assess, compare, critique, elaborate, establish, evaluate, improve, instruct, judge, oversee, protect, refine, relate, restore, specify, standardise, summarize, support, take stock, validate
Create	Create	combine, compile, conceptualise, construct, create, design, develop, draft, explain, manufacture, modify, organise, plan, produce, relate, reorganise, revise, shape, specify, structure, summarize, visualise, write

B2 - Verbs to describe skills

SKILLS		
Skill Levels	**Levels**	**Precise action verbs**
Remember & understand	Perceive	choose, describe, detect, differentiate, distinguish, Identify, relate, select
	Set	count, distinguish, document, estimate, explain, interpret, search, summarize
Apply	Guided response or imitate	employ, follow, react, replace, reproduce, run, sell, supply, execute
	Mechanism or repeat / reproduce	adjust, assemble, calibrate, comply with, construct, consult, correct, dismantle, dismount, divide, draw, exchange, handle, implement, insert, measure, mount, organise, place, process, repair, set up, sketch, stake out, test, transfer
Analysis & problem solving	Complex over response or self-perform / demonstrate	accomplish, adjust, assemble, build, calibrate, commission, communicate, conduct, connect, consolidate, construct, coordinate, decide, delegate, deliver, diagnose, direct, disassemble, dismantle, disseminate, enforce, experiment, explore, follow up, fulfil, guide, install, manage, master, measure, organise, renovate, sketch, supervise
Evaluate	Adaptation or perform / customise (in context)	adapt, assess, configure, eliminate, ensure, lead, rebuild, rehabilitate, reorganise, revise, transform, update
Create	Origination or automatic/unconscious execution	build, combine, construct, create, design, initiate

B3 - Verbs to describe attitude

ATTITUDE		
Skill levels	**Levels**	**Precise action verbs**
Remember & understand	Awareness, willingness to	describe, follow, identify, select, choose
Apply	Responding to phenomena	accompany, assist, introduce, look after, meet, obtain, present, read, recite, report, respond, select

Analysis & problem solving	Value	accept, complete, cooperate, demonstrate, explain, follow, guide, initiate, justify, limit, mobilise, participate, prepare, promote, propose, read, report, respect, select, share, take part, undertake
Evaluate	Organise	approve, collaborate, combine, compare, complete, explain, formulate, identify, integrate, involve, modify, organise, realise, relate, synthesise
Create	Characterise/ internalize	intervene, modify, negotiate, propose, revise, self-evaluate, solve, verify