P4ELECS Platform for Electrification Skills & Competences

P4ELECS WP8 Co-creating Skills Ecosystems

Ecosystem mapping - Interview Process Results The Netherlands

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3 final	16th Feb 2026	Progetto Arcadia – Sara Featherston, Elena Gentilini

Our Partners and Associated partners

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GLOSSARY

BB Building Block
Piece of educational material, consisting of elements (reader, PowerPoint presentation, video, exercises, self-assessment with answer keys, …) related to a particular question or topic.

BBP Building Block Platform
BBP is hosted by Xdemia

CDIO Conceive, Design, Implement, Operate.
Based on the CDIO initiative of MIT

ECOSYSTEMS ROLES (Dedehayir et al 2018)

- leader (it sets up governance through designing roles of the actors, coordinate interactions at both internal and external level, orchestrate resources flows, define platform architecture attracts partners stimulates investments, stimulate value appropriation for producers and end users; as dominator it conducts mergers and acquisitions)
- Value-creation (suppliers, assemblers, platform complementor or user)
- Support (expert or champions in needs of technology or knowledge or other competences, it generates knowledge, encourage technology transfer and commercialization, or build connections among actors, provide access to the market, interacts between partners and subgroups)
- entrepreneurial (entrepreneur or sponsor)
- regulator (definition of laws, provides economics reforms, loose regulatory restrictions).

HEI Higher Education Institutes

INNOVATION ECOSYSTEM

A dynamic, interconnected network of diverse actors and resources that collaborate to drive innovation and create value, a system where innovation is not just a solitary act but a collective, collaborative process.

MATURUTY LEVELS (Moore 1996+ Jutting 2024):

1. birth- emergence of the ecosystem: definition of value proposition among partners, identification of stakeholders. Problem definition, collaboration design, resources definition
2. expansion: value proposition capture value for many stakeholders and make possible the concept scale up to a broader or new markets. needs perspectives, solution components identification, additional knowledge
3. authorities: value adding components and processes are stable and leaders set direction for partners to work together. Implementation capacity, dissemination, political regulation
4. renewal: new ideas and new innovations. Ecosystem value proposition refinement, foresight, impact evaluation

SESCO Skills Ecosystem Coordinator
Individual supporting the establishment of a skills ecosystem, a collaboration between education, government, industry and research to support learners and employees in acquiring requested skills (skills intelligence) and competences.

SKILLS ECOSYSTEM

a network of interconnected actors—including research, education providers, industry, policymakers, and civil society—that collaborates to ensure people acquire relevant skills in an evolving labour market

SPIDER CDIO map that contains BBs relevant to the topic of the spider

SPIDERCO Spider coordinator
Individual responsible for the content and quality of a spider

VET Vocational Education and Training

1. General

1.1 P4ELECS in a nutshell

P4ELECS starts from a strong need in the innovation landscape of the energy sector to support the provision of competences and practical skills for projects relevant to the energy transition, reducing the time needed to go from research to implementation as well as creating flows of knowledge and experiences at international level, through an integrated system.

P4ELECS focuses on electrification, the corner stone of the energy transition, involving partners from 5 countries (BE, NL, IT, LT, DE) from Research, Higher Education Institutes (HEI) and Vocational Education and Training (VET) sectors, industry and innovation support organisations, public authorities responsible for education, accreditation and employment at regional and national levels, to work in a twofold direction and contribute to both VET excellence and Innovation support.

Targeting VETs, HEIs, enterprises, industry-related training providers, engineers and technicians, P4ELECS will focus on:

1. Creating a flexible training offer (with more than 250 modules, 25 courses and 500 participants) at the highest Quality via a user-centric platform as well as practical international experiences based on skill needs intelligence. This can be adapted to the specific educational paths of learners both for initial training and up-skilling and re-skilling and includes key competences, from EQF 5 to 7, in order to cover the whole production cycle from idea to implementation responding to innovation needs.
2. Developing long-term local skills ecosystems (involving over 100 stakeholders) through system mapping and system change coordinated by the P4ELECS CoVE
   - based on providing practical skills and competences as a driving force for life-long learning and closely collaborating with the Higher Education and Research institutes
   - deeply linked to the local innovation ecosystems
   - with a strong international dimension, in sharing knowledge, developing content and training experience.

1.2 Co-creating skills ecosystems: the process up to now

Work Package 8 (WP8) is a foundational component of the **P4ELECS project**, which serves as a "Platform for Electrification Competences and Skills" funded by the ERASMUS+ programme. The primary objective of WP8 is to move beyond traditional vocational excellence models by establishing a comprehensive **Skills Ecosystem (SE)** that addresses the complex, "wicked problems" associated with electrification through collaboration patterns able to respond and adapt to changes, through both horizontal (networks) than vertical relationships (multi-level governance).

Unlike previous initiatives, P4ELECS prioritises **System Innovation (SI)**, an approach rooted in systems thinking that seeks to transform entire systems rather than just individual products or services. Why we decided to use system thinking:

- Addresses complexity and fragmentation in education-innovation-employment chains
- Helps identify patterns, gaps, and long-term priorities
- Ensures learning systems evolve with sectoral innovation.

To achieve these goals, WP8 employs a structured **four-step process** involving six workshops, stakeholders mapping and semi-structured interviews. These steps are designed to move from exploration to tangible development:

1. **Explore (Systems Thinking):** Identifying the purpose of the system and formulating challenge questions.

2. **Understand (Systems Mapping):** Mapping the ecosystem identifying the main specific challenges, current relations and activities to address them
3. **Design (Transition Design):** identify and reframe "leverage points" and designing an activation plan for the system.
4. **Develop (Ecosystem Building):** Implementing the refined strategies within the ecosystem.

For the exploration and mapping phases, we combined interviews, stakeholders mapping, systems analysis and participatory workshops to reveal the deeper dynamics shaping Europe's electrification skills landscape. This mixed-methods approach helped us see the system as it really is — its patterns, relationships and leverage points for change.

- **Interviews:** 40 stakeholders from research, education, industry, and policy across 5 ecosystems have been interviewed to gather cluster information and select priority areas
- **Workshops**: Initial workshops in Genk (Sept 2024) and Arnhem (Sept 2025) identified challenges such as refining skills intelligence and redesigning funding structures.
- **Stakeholder mapping and visualisation**: is performed using tools like **Kumu.io** and **Sumapp** to visualize elements and relations within the ecosystems. It integrates ISSO's knowledge flow roles: 1. Determining the need for knowledge in the electrification sector, 2.Formulating a programme or project, 3.Capturing knowledge, 4.Transfer knowledge, 5.Apply knowledge, 6. Exchange knowledge and experience. It also refers to Cedefop's governance framework and the specific framework
- **Integration**: WP8 links closely with the project's exploitation and dissemination strategy, involving social media channels like LinkedIn and the **Xdemia** platform and participation in forums like the Pact for Skills.

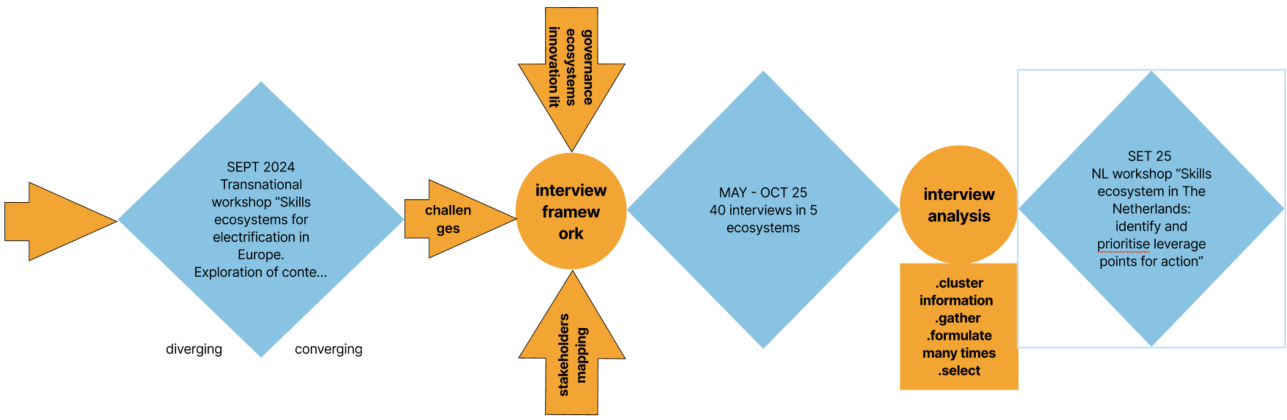

Fig1 WP8 process up to Sept25.

By the end of the project, WP8 aims to deliver:

- A **Memorandum for EU CoVE** and two local agreements among stakeholders on future priorities to be addressed and how, for each regional ecosystem.
- A transnational comparison of ecosystems.
- The launch of **five new services** and the engagement of approximately 150 stakeholders.

The work package focuses on five specific regional ecosystems:

- **Belgium**: Flanders – Limburg – Genk.
- **Netherlands**: East Netherlands – Gelderland – Arnhem.
- **Germany**: North Rhine-Westphalia – Cologne.
- **Italy**: Piedmont – Turin.
- **Latvia**: Riga.

Each local ecosystem in the P4ELECS regions is embedded in a different educational system, characterized by a different relationship between secondary education, tertiary education and life-long learning opportunities. The educational systems have been outlined by P4ELECS project as below. During the initial phase of WP8 "Skills ecosystems development", while working on the mapping of relevant stakeholders, P4ELECS will also explore the current situation of the skills ecosystems with reference to:
- Level of coordination and cooperation in Training development and delivery
- Effectiveness in developing and delivering a training offer that support life-long learning (at different EQF levels) opportunities for the local workforce
- Degree of business – education – research collaboration
- Degree of internationalization in i) training development, ii) learners' opportunities, iii) work-based experiences
- Links to innovation systems.

1.3 Who we are

Work Package 8 is a Team work led by P4ELECS partner Progetto Arcadia in close collaboration with P4ELECS Coordinator Ku Leuven and partners CIM 4.0 and ISSO and P4ELECS Sescos Skills Ecosystems Coordinators. The real people behind are:

Annick Dexters – Professor Power Systems and P4ELECS Coordinator KU Leuven University

Elena Gentilini – Consultant and Researcher Progetto Arcadia and University of Perugia

Sara Featherston – System Change Consultant Progetto Arcadia

Giulia Marcocchia – Innovation Researcher and Consultant CIM4.0 and Cergy Université University, WP8 facilitator and IT Sesco

Martijn Van Bommel - Consultant ISSO and NL Sesco

Leon Verhoeven – Project Manager SEECE Han University and NL Sesco

Stefano Ala – Trainer Forma-rete and IT Sesco

Oskar Krievs – Professor Riga Technical University and LV Sesco

Ansis Avotins – Leading Researcher Riga Technical university and LV Sesco

Christian Dick – Professor Power Elctronics THKoln and DE Sesco,

Andreas Daube – Headmaster Werner-von-Siemens-Schule and DE Sesco

2. The System mapping and the interview process

2.1 Methodology

A **dedicated framework** (see ANNEXES) has been developed, in a collaborative process between Progetto Arcadia, CIM4.0, KU Leuven and inputs and revisions from ISSO and Sescos, to analyse and map the relations behind the skills gap in the European electrification sector, specifically focusing on the five P4ELECS regional ecosystems: Flanders (Belgium), East Netherlands, North Rhine-Westphalia (Germany), Piedmont (Italy), and Riga (Latvia). The project utilizes a specific workflow involving stakeholder mapping and system thinking analysis (transnational workshops and interviews) to uncover the underlying local challenges to improve skills provision for electrification.

An initial workshop (2024) among P4ELECS partners based on skills ecosystems literature and Centre of Excellence experiences was held to analyse the current context and main challenges affecting the provision of skills for the energy transition. The workshop returned common systemic challenges:

1. Siloed organisations and poor cross-sector collaboration
2. Education lags behind rapid innovation

3. Fragmented training and lack of lifelong learning culture

+ 10 sub-challenges . among these for example:

- Misaligned stakeholder goals
- Competition vs collaboration
- Underestimation of practice
- Social/cultural barriers; lack of funding/time.

These results were coupled with analysis on stakeholders typologies in each ecosystem and their role and activities, and with questions arising from selected scientific and policy literature on system thinking, governance, skills and innovation ecosystems[1] to identify the main objectives of the mapping process and the interviews framework:

- **General idea about Respondent and Stakeholder organisation.** Gather information on respondent and his/her role, organisation, category of organisation according to the stakeholder mapping used in P4ELECS, data on employees and annual learners if applicable, main organisation activities in education according to the stakeholder mapping. Relations between educational and innovation activities over time was also explored.
- **Identify Stakeholder organisation vision and strategy and potential at ecosystem level.** Describe it especially toward the development of a local innovation and skills ecosystem and find shared points with and stakeholder's perspective on the current local skills ecosystem and with P4ELECS**.**
- **Identify the main current and potential collaboration and governance patterns.** Determine how the stakeholder see the current collaboration and governance, gather information on ecosystems maturity and on the stakeholder current functions/roles.

This led to develop the main areas to be addressed through a careful selection process among the work package team members as well as the main tools (interview structure, guide, C&D and planning tools – see ANNEXES) employed and to the selection and involvement of 8 stakeholders per each ecosystem, with the substantial work of Sescos under the coordination of Progetto Arcadia.

Interviews were 1 hour long and carried out between March 2025 and February 2026, facilitated by Progetto Arcadia.

Analysis of interviews was qualitative.

What we looked for in each ecosystem:

- Main challenges – most recurrent OR developed (meaning that interviewed people talked extensively about it)
- Sub-challenges - more specific challenges linked to the previous ones
- Special roles with functions and specific challenges

Each ecosystem is specifically described in terms of:

- Context
- Values and opportunities
- Roles within the ecosystem
- Ecosystem needs
- Challenges
- Opportunities for The Netherlands and P4ELECS

Some local insights on the main challenge from the 5 regions emerged:

- Belgium: the ecosystem next phase and where to go next, to improve coordination and minimise overlapping.

[1] E.g Dedehayir, Ozgur, Makinen, Saku, & Ortt, Roland (2018) Roles during innovation ecosystem genesis: A literature review. *Technological Forecasting and Social Change*, *136*, pp. 18-29; Guilherme Brittes Benitez, Néstor Fabián Ayala, Alejandro Germán Frank Industry 4.0 innovation ecosystems: an evolutionary perspective on value cocreation, International Journal of Production Economics (Elsevier), Volume 228, October 2020. The main literature from ETF, Cedefop, COVEs Community and European Union strategies (including The Pact for Skills) was analysed.

- Netherlands: theory vs practice. System produces too few site-fluent installers and too many theoretical graduates disconnected from real-world practice.
- Germany: rich innovation, but decreasing quality learning.
- Italy: slow training adaptation and lack of systemic integration between education and industry.
- Latvia: dynamic innovation, but lack of a supportive context, due to outdated policy and infrastructure.

The results of the analysis set the ground to describe and understand each context and identify potential challenges, carefully selected, to bring to Local workshops for system change (from Sept 2025 onwards) and to find leverage points for action. This marks the start of the ideation phase.

A Contry-specific report will be produced for each ecosystem and a trans-national report will also be produced to analyse:

- common challenges across ecosystems: to explore in the current workshop phase underlying structures and mindsets and future local action plans
- initial comparison and ideas for transfer/cross/exchange/co-design/collaborate among ecosystems
- ideas for the European level - as well as international cooperation.

And start the ideation for the global COVE.

2.2 Content of interviews. Main areas addressed.

The interview structured has been organised in three sections. It is important to highlight that the structure was anticipated to all respondents in an explicative email and that was only indicative. This means that depending on the conversation and the respondent priorities and topics, the interview would follow the course in some cases skipping some questions. A limited set of questions was deemed the core of conversation and agreed would be asked in any interview to create consistency and comparability. An internal structure was also developed for internal purposes, listing also sub-questions that could help guiding the conversation.

The three sections were:

Section 1 Role and Organisation – 7 questions, 2 sub-questions/specifications.
"In this section we are going to explore your organisation and your role within it, especially with reference to educational activities and the electrification sector".

- Background and expertise
- Category and description of the organisation
- Nr employees
- Provision of training – and relative weight compared to innovation activities
- Nr of annual learners
- Subject specialisation + excellence/problems
- Core activities.

Section 2 – Vision and ambition – 6 questions, 9 sub-questions/specifications.
"In this section we are going to explore your organisation's vision and ambition and your analysis of the current skills ecosystem you work in".

2.1 Organisation

- Vision 5 years
- Interest in P4ELECS

2.2 Ecosystem

- Vision at ecosystem level
- Strengths in innovation
- Strengths in skills development

Section 3 – Collaboration and governance – 4 questions, 7 sub-questions/specifications.

- Actors of innovation and relationships
- Actors of skills provisions and relationships

- How are decisions taken, values and level of effectiveness
- Methods of allocation of education fundings

For the full set of questions see ANNEX 1 Interview structure and ANNEX 2 Guidelines

2.3 Organisations interviewed.

The full list of respondents as of today (we are missing four interviews in Germany and 1 in Latvia) is:

Belgium

Matilde Defraeije FLUX50 – Other (Networking)

Pieter Willems EQUANS – Industry (large)

Bert Lauwers KU LEUVEN –Research and Education (HEI)

Wouter Wissinck VOLTA – Industry (intermediary)

Anne Caelen VDAB – Other (policy)

Katrien Goossens UCLL – Education (Applied)

Saskia Van Uffelen, Jean-Marc Timmermans AGORIA – Industry (intermediary)

Frank Gielen IET INNOENERGY – Research and Innovation (Funding) and Education (EU level)

The Netherlands

Henry Lootens DC Foundation – Industry (SME, service)

Koen Veldman Techniek Nederland – Industry (technology)

Jeroen Herremans CONNECTR – Research

Marsha Wagner TOP SECTOR ENERGIE – Research

Berend Koudstaal ISSO - Research

Bart van Ham RVO – OTHER (policy)

Ballard Bediake Assaro Duurzaam Energie Perspectief – Industry (large)

Pieter van Schaik TU Delft – Education (HEI)

Italy

Lorenzo Perelli ISMA Controlli

Mauro Cornaglia ENVI PARK – Other (regional development agency)

Marco Aimoboot IVECO GROUP – Industry (large)

Enrico Pisino CIM4.0 - Research

Stefano Ala Forma-rete – Education (VET)

Claudio Lauriola Domocla – Industry (SME)

Silvio De Nigris PIEDEMONT REGION – Other (policy)

Fulvio Corno Politecnico di Torino – Education (HEI)

Vincenza Nicastro Irengroup – Industry (large)

Latvia

Edgars Kuks VIZULO – Industry (SME)

Kristina Berzina BLEEA – Industry (intermediary)

Andrejs Cehanovičs Sadales tīkls – Industry (large)

Ralfs Ērkšķis Ventspills Tehnikums – Education (applied/VET)

Reinis Ernestsons ADDO ENERGY – Research

Oskars Krievs, Ansis Avotins RIGA TECHNICAL UNIVERSITY – Education (applied)

Valters Krasts Department of the Riga City Municipality Outdoor Space and Mobility Department – Other (policy)

Germany

Johanna May TH Koln – Education (applied)

Bernd Bitterlich ECPE network – Industry

Tillman Blume SMA Solar Academy – Industry and Education (VET)

Ilona Acaro TH Koln Academy – Education (HEI)

3. Results – The Netherlands

3.1 The Context

The Netherlands presents a highly advanced electrification ecosystem, characterized by strong research capacity, ambitious public policy, and a dense network of innovation actors. Despite this maturity, the ecosystem is currently constrained by structural fragmentation within the skills and workforce landscape.

Analysis based on interviews with seven key stakeholders reveals a persistent disconnect between the **Innovation System** (research institutions, public funding instruments, startups, and policy frameworks) and the **Implementation System** (installers, SMEs, grid operators, and vocational training providers). While innovation activities are well supported across Technology Readiness Levels (TRL) 1 to 9, insufficient attention and resourcing are directed toward the translation of innovation into standardized skills, training pathways, and workforce readiness beyond TRL 9.

Fragmentation between innovation and market implementation, specifically:

- **Innovation reaches market readiness, integration does not:** interviewees describe a gap emerging after technologies reach **Technology Readiness Level (TRL) 9**, when market readiness is assumed but organizational, educational, and workforce integration remains limited.

- **Funding prioritizes novelty over uptake:** attention and resources are described as remaining focused on developing new innovations, with little allocation toward supporting how existing technologies are absorbed into organizations or educational contexts.

  "Nobody thinks, hey, we should have one to five percent of this amount of money to see how does this new innovation land in our organisations or in educational purposes."

- **Implementation is project-based and short-lived:** rather than shared or sustained infrastructure, initiatives are frequently organized as standalone projects that conclude when funding ends, resulting in fragmented resources and limited continuity.

  "Everyone makes their own foundation, their own website, their Academy… Everybody makes their own niche… they all whine. Nobody comes on our… nobody visits our website."

- **Prototyping outpaces early adoption:** from a market perspective, interviewees note a disconnect between developing new products or solutions and finding actors willing to adopt them at an early stage.

- **Risk aversion limits first-mover uptake:** even when innovations exist, adoption can be constrained by a lack of market actors willing to take on the initial risk associated with being the first buyer or user.

  "If you come up with a nice idea, but nobody is willing to take the risk to buy the first product… you're gonna have a hard time there."

Fragmentation between theory (education) and practice (reality), specifically:

- **theoretical training diverges from hands-on practice:** interviewees describe differences between what is taught in educational programs and the practical realities of working with electrical systems. EQF 5 is not well enough developed.

- **limited exposure to real equipment during education:** graduates may complete relevant degrees while remaining unfamiliar with the physical infrastructure and tools used in practice.

  "I graduated on power quality… and then I was like, they gave me a machine in my hands… and I was like, what is this? Because I only know it from PowerPoint and books."

- **inconsistent engagement with technical documentation in practice:** installations are described as sometimes being carried out without close attention to manuals or specifications.

  "Installations are being done by people that don't even read the manual."

- **education cycles move slower than market demand:** interviewees point to a temporal mismatch between long educational development cycles and rapidly evolving industry needs.

  "We have to do it still with the old world who has a development cycle of seven years. And the necessity of the market? Who wants something within nine months?"

- **shift toward broad 'energy' education over technical specialization:** educational programs are described as emphasizing general energy topics rather than specialized electrical engineering skills.

  "We focus on energy broad… but we want electrical engineers, the two are not the same… You are having more energy engineers and less electrical technical engineers."

Fragmentation of collaboration and stakeholders, specifically:

- **stakeholders operate in silos rather than as an interconnected system:** interviewees frequently describe fragmented ways of working between professions and within organizations.

- **task-based focus limits cross-role coordination:** professionals, particularly in construction-related contexts, are described as concentrating narrowly on their own responsibilities, with limited attention to how their work connects to others.

  "Everybody is focused on their own tasks and they don't care about other tasks."

- **commercial interests constrain system-wide perspectives:** maintaining a broader system view is described as difficult where individual or organizational commercial incentives dominate.

  *"The system perspective is very difficult to keep on the agenda because everybody has an interest… You only want to sell your ****."*

- **organizational silos exist within public institutions:** departments within organizations such as RVO are described as operating separately, including in relation to subsidy structures and funding mechanisms.

  "Yeah, we have silos… It's not so that other departments have the same subsidy."

- **regional collaboration opportunities are not always visible:** even when actors are geographically close, interviewees describe limited awareness of potential partnerships or joint initiatives.

  "They know each other, but they didn't know the possibilities of working together."

Fragmentation by company size and regulatory pressure, specifically:

- **regulatory exposure differs by company size:** interviewees describe differences in how regulatory requirements affect large, medium-sized, and small firms.

- **large firms absorb compliance costs through scale:** larger companies are described as managing regulatory and compliance requirements through internal resources, dedicated teams, or acquisition strategies.

  "The bigger companies are getting bigger and they buy the medium businesses…"

- **small firms face lower regulatory exposure:** smaller companies may fall below regulatory thresholds or enforcement intensity due to their size, turnover, or project scope.

  "Smaller companies are able to go underneath the radar…"

- **'going under the radar' reflects reduced oversight:** in this context, interviewees use the term to describe limited exposure to regulatory oversight, reporting requirements, or enforcement.

- **medium-sized firms face full compliance without scale advantages:** medium-sized companies are described as being fully subject to regulatory requirements while lacking the scale or internal capacity of larger firms to absorb associated costs.

  "But the middle bit companies, they have to pay it, but it's costing them margins."

- **market structure reflects firm-size polarization:** interviewees describe a market structure in which large and small firms are more prevalent, with fewer medium-sized companies remaining.

This gap is further intensified by two systemic pressures. First, grid congestion increasingly limits the pace at which electrification solutions can be deployed. Second, the sector faces a growing shortage of technically qualified personnel, particularly those with strong electrical engineering fundamentals. Interviewees describe a fundamental shortage of people in the workforce, creating a situation in which **multiple sectors compete for the same limited pool of talent**.

Competition for talent and workforce dynamics are shaped by overlapping recruitment demands, sectoral pull, and changing workforce expectations, specifically:

- **multiple sectors draw from the same talent pool:** interviewees describe concurrent recruitment across sectors such as energy, health, and education, all targeting a similar group of qualified individuals.

  "Everyone is fishing in the same boat… everybody is more or less coming for the same… qualified people."

- **talent is absorbed by large technology firms:** even when students graduate with technical degrees, many are described as entering large technology companies rather than applied or installation-focused roles.

  "If you finish university… you go to ASML… Philips… You're not working at an installer."

- **availability of hands-on technical workers is reduced:** this dynamic is described as limiting the number of technically trained individuals entering sectors that rely on practical implementation and installation work.

- **workforce expectations are shifting:** interviewees point to broader cultural changes, particularly among younger generations, toward prioritizing work–life balance and stable quality of life.

- **high turnover affects workforce continuity:** employees are described as frequently leaving roles after relatively short periods, often one to two years, contributing to ongoing workforce churn.

Across interviews, stakeholders expressed a shared concern that conceptual discussions on systems integration are not yet matched by operational practice. In practical terms, innovation is advancing faster than the workforce can absorb, apply, and maintain it safely at scale.

This gap is reinforced by the way standards and technical frameworks are developed. Henry Lootens, reflecting on the Dutch approach of "learning by doing," described how engineering concepts developed at the desk often fail when applied to physical infrastructure. Using public lighting projects as an example, he explained that ideas which appeared sound in PowerPoint proved unworkable in real-world conditions, requiring standards to be rewritten only after failures in the field. This dynamic reveals a broken feedback loop in which standards are shaped primarily by theoretical expertise rather than lived, on-site experience. As a result, cognitive complexity accumulates at the desk while practical work is progressively simplified, leading to a situation where those responsible for implementation lack a deep understanding of what they are installing and maintaining. This further weakens the system's capacity to translate innovation into reliable, scalable practice.

Within this context, the Netherlands serves as a critical case for P4ELECS, illustrating the importance of strengthening the interface between innovation, education, and implementation.

3.2 Values and Opportunities

Despite the challenges identified, the Dutch ecosystem exhibits several enabling conditions that create opportunities for targeted intervention through P4ELECS.

3.2.1 Policy Pragmatism and Incremental Transition

Public authorities, particularly within the Netherlands Enterprise Agency (RVO), demonstrate a pragmatic orientation toward the energy transition. There is a visible shift away from rigid interpretations of “100 percent fossil-free” solutions toward hybrid and transitional approaches that prioritize speed and cumulative impact.

This orientation supports modular, stepwise approaches to skills development and lifelong learning, aligned with the P4ELECS building-block model.

3.2.2 Demand for Knowledge Translation and Standardization

Stakeholders consistently emphasized the need to convert experimental and fragmented innovation outputs into stable, accessible formats such as standards, guidelines, and training modules. There is strong recognition that innovation alone does not lead to impact unless it is translated into practical and teachable knowledge.

3.2.3 Availability of Real-World Test Environments

The Netherlands benefits from applied testing environments such as The Green Village at TU Delft. These facilities allow technologies and training approaches to be validated under real-life conditions before large-scale deployment, reducing risk for both industry and educators.

3.2.4 Proven Models of Ecosystem Coordination

Initiatives such as It demonstrate that neutral facilitation and dedicated coordination roles can successfully bridge institutional and competitive boundaries. These models offer transferable insights for skills ecosystem governance within P4ELECS.

3.3 Roles Within the Ecosystem

The Dutch electrification ecosystem is characterized by clearly differentiated stakeholder roles. Each actor contributes to specific parts of the system, yet no single mechanism ensures alignment across innovation, education, and implementation.

As it stands:

- No actor owns cross-system alignment
- No mandate spans innovation, standardization, education, and deployment
- Coordination depends on goodwill, informal networks, or temporary projects

Instead, each actor optimizes for their own function:

- Policy focuses on funding logic and momentum
- Knowledge institutions focus on codification post TRL 9
- Grid operators articulate demand but cannot steer education
- Industry focuses on economic pressure rather than skills design
- Field labs test innovation but sit outside formal training systems

Therefore, alignment is assumed, not governed:

- Quotes like *“Nobody thinks about how innovation lands in organisations or education”* directly point to a systemic blind spot.
- Coordination only happens when **someone actively curates it**, not because the system structurally ensures it.

3.3.1 Policy Enabler

Redefines the role of the public funding agency from a gatekeeper of "perfect" green solutions to an enabler of pragmatic momentum.

“The ecosystem must focus on integrating smaller, imperfect, but immediately available "building blocks".

“Sometimes perfect is the enemy of good”

This perspective suggests the skills ecosystem should not focus solely on training for the ultimate future state (2040), but must urgently provide flexible, modular skills that enable technicians to install and manage intermediate, deployable solutions such as hybrid heat pumps, cable pooling arrangements, and smart energy management systems that allow electrification to progress despite current grid congestion and infrastructure constraints.

3.3.2 Knowledge Codifier

It operates at the interface between innovation and application, translating mature technologies into standards and guidelines for market and educational use.

“When things are liquid knowledge, it’s new and innovative. After TRL 9, that’s where guidelines need to be made.”

He also highlighted a structural failure in the system:

“Nobody thinks about how innovation lands in organisations or education. That is a systemic failure.”

3.3.3 Grid Operator / Demand Side

Grid operators articulate clear technical skill requirements linked to system reliability and safety, yet have limited influence over education timelines and curricula.

“We focus on energy broadly, but what we need are electrical engineers.”

This mismatch contributes directly to implementation constraints.

3.3.4 Industry Advocate

It represents installers and service providers, with a particular focus on the pressures faced by SMEs.

“They feel it in their margins.”

Regulatory and compliance demands disproportionately affect mid-sized companies, limiting their capacity to invest in training.

Regulatory and compliance demands disproportionately affect mid-sized companies, limiting their capacity to invest in training.

Interview evidence shows that regulatory pressure impacts companies unevenly depending on size, placing mid-sized firms in a structurally constrained position. They explain that the market is increasingly polarizing because the “middle segment" cannot absorb regulatory burden in the same way as large firms or avoid it in the way smaller firms sometimes can. Large companies typically respond to new regulations by hiring additional compliance or quality management staff and treating these costs as part of doing business. Small companies may remain below the threshold of strict enforcement. Mid-sized companies, particularly those with 35–70 FTEs, must fully comply but experience compliance costs directly as reduced margins.

These compliance costs limit financial flexibility. Veldman notes that money spent on meeting regulatory requirements competes directly with investments in staff training, skills development, and innovation. He also observes that sustained regulatory pressure influences ownership decisions, with some mid-sized business owners choosing to sell to larger companies because they cannot manage the growing volume and complexity of rules.

Operational capacity further constrains investment in training. Mid-sized companies face the same regulatory and administrative obligations as large firms but typically lack dedicated HR or IT staff to manage them. In companies with 35–70 FTEs, these responsibilities fall largely on owners or managers, increasing workload and reducing available time and resources for training activities.

Financial barriers extend to innovation and skills testing. Testing new technologies can cost around €50,000. While such costs are manageable for large companies, small and mid-sized firms often lack the financial capacity to participate without subsidies.

At a system level, it was highlighted that SMEs struggle to keep pace with the volume and speed of new developments, including the need to train staff across many emerging technologies simultaneously.

3.3.5 Technical Connector

Technical experts emphasize safety, system integrity, and the risks associated with superficial training.

"Installations are being done by people who don't even read the manual. It has to be safe and doable by design."

He also noted a broader disconnect between theory and practice:

"We talk a lot about system thinking in the Netherlands, but actually nobody does it."

3.3.6 Ecosystem Builder

It operates as an **active intermediary** in the energy transition, focused on bridging the gap between innovation and scaling. Rather than functioning as a passive network, it deliberately constructs value chains and manages relationships so that innovations reach the market.

Their work is structured around three core pillars:

- **Physical meeting spaces**
  It provides physical environments where stakeholders meet, based on the premise that collaboration requires repeated, in-person interaction.

- **Shared facilities through an "owner" model**
  Instead of building and owning labs themselves, It identifies a concrete need (such as testing equipment), finds the market party that benefits most from owning the asset, helps secure subsidies to finance it, and establishes a business model that allows other parties to access the facility. This ensures infrastructure is both

financed and used.

- **Long-term innovation programmes and funding (3–5 year horizon)**
  Their programmes are oriented toward market needs several years ahead, such as infrastructure requirements linked to future grid targets, ensuring that innovation remains aligned with upcoming demand rather than short-term experimentation and that funding supports coordination.

Beyond these pillars, It plays an **active mediation role**:

- They use a "client of the client" strategy to generate engagement and clarify market demand. To bring technology suppliers to the table, It invites the end users of those technologies. When companies such as Ahold or DHL are present, original equipment manufacturers like Volvo or Mercedes, as well as charging infrastructure providers, are motivated to participate. Hearing directly from these major customers allows suppliers to understand what is actually being asked of them in the market. When end users articulate their operational needs, suppliers recognize that adapting their products and services to meet these requirements creates added value for their clients. This direct exposure to future customer demand motivates suppliers to engage and align their development efforts accordingly.

- They remain involved throughout collaborations, including managing situations where partnerships break down, ensuring that relationships remain usable within the ecosystem.

- They build trust through recurring, challenge-specific communities where stakeholders meet regularly, enabling coalitions to form over time and compete for major European tenders.

Finally, It also **validates market demand for education**. They develop masterclasses to demonstrate that specific skills are needed by industry, then hand these validated concepts over to universities to scale into formal programmes, reducing the risk for educational institutions.

It facilitates collaboration and trust across the ecosystem through neutral coordination and shared infrastructure.

"They knew each other, but they didn't know the possibilities of working together."

This role demonstrates the importance of active mediation rather than passive networking.

3.3.7 Field Lab Operator

Field labs provide regulatory-free environments for testing innovations with real users.

"People test prototypes and learn what works and what doesn't when real users are involved."

However, these environments remain weakly connected to structured vocational training pathways.

3.4 Ecosystem Needs

Across interviews, several shared needs emerged that are directly relevant to P4ELECS.

- A clearer and faster pathway for translating innovation outputs into training content

- Modular, practical training that can be deployed quickly in response to industry demand
- Stronger reinforcement of electrical engineering fundamentals alongside emerging technologies
- Dedicated coordination roles to connect education providers, SMEs, and industry
- Greater alignment between funding for innovation and funding for workforce readiness

These needs point to gaps not in knowledge creation, but in knowledge transfer and application.

3.5 Challenges

Four structural challenges consistently limit progress in the Dutch ecosystem.

3.5.1 Absence of Clear Ownership

Cross-sector challenges such as skills shortages and grid congestion lack a single actor with both mandate and financial capacity.

“There’s not really a problem owner.” — Henry Lootens

Based on the interviews:

- **Sectors are optimized for isolation, not integration**
 Within sectors, systems tend to produce highly specialized roles rather than integrators. University experts can be extremely knowledgeable within narrow domains, yet struggle to connect their expertise to adjacent technologies or systems. Within the installation sector, work is increasingly simplified to cope with labor shortages, leading to imitation based execution rather than deeper understanding.

- **Internal systems are misaligned with market speed and needs**
 Even when sectors operate as designed, their internal rhythms do not match the pace required by the energy transition. **E**ducation systems typically operate on multi year development cycles, while market demand evolves within months. Other add that graduates often lack the practical electrical foundations required by grid operators, forcing companies to compensate through internal training.

- **No ownership of cross cutting problems**
 Problems that sit between sectors often have no clear owner. Some describe a pattern of responsibility being passed along without resolution, with issues addressed only after failures occur. Other reinforce this by pointing to a systemic gap between innovation and implementation, where new technologies are developed but not absorbed by SMEs, with no actor responsible for managing that transition.

- **Internal fragmentation within sectors**
 The interviews also show that sectors are not cohesive units. Someone notes that even within a single organization, different teams may duplicate work unknowingly. Other highlight internal strain within the business sector itself, where mid-sized companies are squeezed between large firms and small players.

3.5.2 Imbalance Between Innovation and Implementation

Public funding prioritizes technology development over deployment and workforce training.

“Nobody thinks about allocating one to five percent of innovation funding to training.”

3.5.3 Decline of Electrical Engineering Fundamentals

Broad energy-focused education pathways dilute essential technical depth.

“We have more energy engineers and fewer electrical technical engineers

3.5.4 SME Capacity Constraints

Regulatory and compliance frameworks disproportionately affect mid-sized companies, limiting their ability to invest in skills development.

3.6 Opportunities for the Netherlands from P4ELECS

The Dutch electrification ecosystem highlights a clear opportunity for P4ELECS to deliver value beyond training provision, by strengthening how skills are developed, coordinated, and sustained across levels.

At the **local level**, installers, SMEs, and field labs are actively engaging with DC technologies, but lack fast, flexible pathways to acquire the specific skills needed for safe and effective implementation. This creates a strong case for P4ELECS to deploy **modular “building blocks”** that respond directly to real-time demand, supporting reskilling and upskilling without reliance on long, rigid education pathways.

At the **regional level**, the Netherlands shows that collaboration is possible but not structurally embedded. Ecosystem actors know each other, yet coordination relies on informal relationships and project-based facilitation. Here, P4ELECS can play a critical role in **co-creating sustainable skills ecosystems** by strengthening governance arrangements, supporting neutral coordination roles, and improving alignment between employers, training providers, and research actors. This directly supports the project’s objective to connect demand and supply within the skills ecosystem.

At the **national level**, innovation and policy frameworks are strong, but the transfer of research into training remains slow and inconsistent. The Netherlands case illustrates the need for a structured **research-to-training pipeline**, particularly through stronger collaboration between Higher Education and VET providers. P4ELECS’ focus on the **VET–Higher Education handshake** positions the project to address this gap by ensuring that innovations in DC technology are translated into training content across EQF levels 3 to 7.

As the Dutch thematic hub for **DC technology**, the Netherlands offers a valuable testing ground for P4ELECS’ broader ambitions. By piloting flexible learning building blocks, platform-based knowledge sharing, and ecosystem governance mechanisms in this context, P4ELECS can generate transferable models for other regions and thematic areas within the project.

In summary, the Netherlands ecosystem demonstrates that the primary challenge is not the absence of innovation, but the absence of structured pathways that connect innovation to workforce readiness. P4ELECS is well positioned to address this challenge by integrating ecosystem development, educational innovation, and thematic specialization, turning existing strengths into scalable and sustainable impact across Europe.

"Innovation is the problem... not the innovation on itself, but the innovation system is the problem". He argues, "Everything we need to solve world problems is already available... It's all physics... we don't need more innovation. We need skilled people who understand new technology"

The ecosystem is stuck in a phase of "liquid knowledge" (new, flowing, unstable) that never "coagulates" (becomes standardized, teachable, and structural),. Because no mechanism exists to solidify this knowledge, it flows away when projects end.

"Everyone makes their own foundation, their own website, their Academy... Everybody makes their own niche... they all whine. Nobody comes on our nobody visits our website". This leads to a situation where technicians want to learn but "don't know where they can find the knowledge" because it is dispersed across countless disconnected platforms.

"We talk a lot about. System thinking in the Netherlands, but actually nobody does it". Instead, the mechanism is to "Throw it over the fence," where parties pass responsibility to the next link without ensuring the problem is actually solved.

Because the knowledge circle is not governed, the innovation never reaches the technician in a usable form.

Because the knowledge circle is not governed, the innovation never reaches the technician in a usable form.

There is no playbook because stakeholders are incentivized to focus on the next innovation rather than the boring, difficult work of implementation.