AI 4 GREEN DEAL

Skill gap Analysis and Product Strategy

Deliverable D2.1 | May 2026

Co-funded by the European Union

Funded by the European Union under Grant Agreement n°101226189. Views and opinions expressed are those of the author or authors and do not necessarily reflect the views of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

Project	**AI4GreenDeal**
EC-grant agreement	101226189
Programme	Digital Europe Programme (DIGITAL)
Client	European Health and Digital Executive Agency (HaDEA)
Start of the project	01.09.2025
Duration	48 months
Document title	Skill gap analysis & product strategy
Work package	2
Deliverable	2.1
Lead beneficiary	KU Leuven
Project coordinator	InnoEnergy
Dissemination level	Public
Authors	Arnaud Verstraeten, Fereshteh Poormohammadi, Hussain Syed Kazmi, Ruth Sabariego, Johan Driesen
Reviewers	Eylem Tasdemir (InnoEnergy) Inge de Waard (InnoEnergy) Lucia Grilli (Schuman Associates) Marc Jené Vinuesa (UPC) Winnie Vanrespaille (ESADE)
Description	An official report in English summarising the findings about the validated skill gaps and opportunity analysis. This will serve as the basis to outline of the product strategy.
Status	Final
Delivery date	29.05.2026
Due date	31.05.2026
Approval date	28.05.2026

Revision history			
Version	Date	Modified by	Comments
1	13.04.2026	Eylem Tasdemir	
2	17.04.2026	Winnie Vanrespaille	
3	21.05.2026	Lucia Grilli	
4	26.05.2026	Marc Jené Vinuesa	

Co-funded by the European Union

Funded by the European Union under Grant Agreement n°101226189. Views and opinions expressed are those of the author or authors and do not necessarily reflect the views of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

Project: 101226189 — AI4GreenDeal — DIGITAL-2024-ADVANCED-DIGITAL-07

Skill gap analysis & product strategy, 2026.

Deliverable D2.1: “Skill gap analysis & product strategy”

Legal Disclaimer

The European Commission’s support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Co-funded by the European Union

Funded by the European Union under Grant Agreement n°101226189. Views and opinions expressed are those of the author or authors and do not necessarily reflect the views of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

AI 4
GREEN DEAL

ABOUT AI4GREENDEAL

Data & AI skills are growing in importance in the energy sector and become key requirements for energy engineers. To achieve the Green Deal objectives of reducing greenhouse gas emissions, increasing energy efficiency, and promoting the integration of renewable energy sources, education providers need to accelerate the training of engineering talents and energy professionals in digital skills.

The AI4GreenDeal project aims to design and deliver a 120 ECTS Master's double degree programme that uniquely combines energy domain knowledge with data & AI skills, and innovation and entrepreneurship skills. The project also plans to offer flexible and stackable self-standing modules certifying a wider audience of learners, including working professionals.

The project will implement a comprehensive curriculum based on the InnoEnergy Data Science for Energy Engineers skills framework validated by an industry advisory board. It will employ active learning and project- and challenge-based learning approaches, co-designed and co-delivered with industry partners.

The project will use a part of the grant to award scholarships, fee waivers and mobility budgets to applicants, and aims to reach a minimum of 150 students graduating or starting the full degree programme, and 300 learners obtaining a professional certificate by the end of the project. A financial sustainability plan will guarantee the continuation of the new educational offering by InnoEnergy Masters+.

Co-funded by
the European Union

Funded by the European Union under Grant Agreement n°101226189. Views and opinions expressed are those of the author or authors and do not necessarily reflect the views of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

AI 4
GREEN DEAL

THE AI4GREENDEAL CONSORTIUM

The project consortium consists of 3 university partners, 1 associated university partner, 1 business school, 1 research partner and 8 industry partners from 10 EU countries, coordinated by InnoEnergy. The industry partners will take an active role in the design, implementation and dissemination activities ensuring maximum fit to the skill gap for advanced data & AI skills in sustainable energy.

Partners	Acronym
KIC INNOENERGY SE	KIC SE
THE INSTITUTE OF SUSTAINABLE ENERGYSTICHTING	ISE
KIC INNOENERGY IBERIA SL	KIC IE IBERIA
KATHOLIEKE UNIVERSITEIT LEUVEN	KU Leuven
UNIVERSITAT POLITECNICA DE CATALUNYA	UPC
INSTITUT POLYTECHNIQUE DE GRENOBLE	INP GRENOBLE
FUNDACION ESADE	ESADE
NIIT (Ireland) Limited	NIIT (IRL) Limited
WATT-IS SA	WATT-IS SA
KIMITISIK B.V	Kimitisik
TOKWISE OOD	TokWise Ltd.
GeoBeholder OU	Beholder
Ento Labs ApS	Ento Labs ApS
ASTROKYON SP.ZO.O.	Astrokyon
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	CSIC

Co-funded by the European Union

Funded by the European Union under Grant Agreement n°101226189. Views and opinions expressed are those of the author or authors and do not necessarily reflect the views of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

Table of contents

Co-funded by the European Union

Funded by the European Union under Grant Agreement n°101226189. Views and opinions expressed are those of the author or authors and do not necessarily reflect the views of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

List of tables

Co-funded by the European Union

Funded by the European Union under Grant Agreement n°101226189. Views and opinions expressed are those of the author or authors and do not necessarily reflect the views of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

Glossary

Abbreviation	Definition
AESAI	Advanced Energy Systems and AI
AI	Artificial Intelligence
AI4GD	AI4GreenDeal
CDE	Communication, Dissemination and Exploitation
EC	European Commission
ECTS	European Credit Transfer and Accumulation System
EFSC	Energy for Smart Cities
EHEA	European Higher Education Area
ESADE	ESADE Business School (Escola Superior d'Administració i Direcció d'Empreses)
EU	European Union
HaDEA	European Health and Digital Executive Agency
IEA	International Energy Agency
INP	Institut National Polytechnique (Grenoble INP)
IRENA	International Renewable Energy Agency
KIC	Knowledge and Innovation Community
KTH	KTH Royal Institute of Technology (Kungliga Tekniska högskolan)

Co-funded by the European Union

Funded by the European Union under Grant Agreement n°101226189. Views and opinions expressed are those of the author or authors and do not necessarily reflect the views of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

KU Leuven	Katholieke Universiteit Leuven
LLM	Large Language Model
ML	Machine Learning
OECD	Organisation for Economic Co-operation and Development
RE	Renewable Energy
RESP	Renewable Energy Skills Partnership
SQL	Structured Query Language
UNRIC	United Nations Regional Information Centre for Western Europe
UPC	Universitat Politècnica de Catalunya
VET	Vocational Education and Training
WEF	World Economic Forum
WP	Work Package

Co-funded by the European Union

Funded by the European Union under Grant Agreement n°101226189. Views and opinions expressed are those of the author or authors and do not necessarily reflect the views of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

Executive Summary

The rapid advancement of artificial intelligence (AI) is transforming virtually every sector of society, generating substantial productivity gains and enabling new forms of innovation across industries. In the energy sector, AI-driven methods have demonstrated significant potential in processing and analysing large-scale energy datasets, enabling improvements in operational optimisation, forecasting accuracy, system monitoring, automation, and decision-making transparency.

Alongside the accelerating digital transformation, the energy sector is simultaneously undergoing a profound transition towards climate neutrality and the reduction of greenhouse gas emissions. Addressing this dual transition — digital and green — requires a new generation of professionals equipped with interdisciplinary competencies that combine advanced energy engineering knowledge with digital and AI-related skills.

However, traditional energy engineering education has generally focused on core engineering disciplines, with limited integration of digital competencies such as data science, artificial intelligence, machine learning, and data-driven decision-making. In response to these emerging challenges, the AI4GreenDeal project seeks to transform the existing *Energy for Smart Cities* curriculum into the *Advanced Energy Systems and AI* programme, incorporating a strong emphasis on digitalisation, data science, and AI applications for the energy sector.

This report presents a structured assessment of the existing skills gap between current higher education provision and evolving industry requirements. As a first step, the current skills supply was analysed through a review of the existing curricula offered by partner universities. The analysis confirms that current programmes provide a solid foundation in core energy engineering domains, including thermo-mechanical systems, electrical engineering, and techno-economic analysis. Nevertheless, the integration of digital and AI-related competencies within these programmes remains limited.

To assess the demand side of the skills gap, the study examined rapidly evolving industry requirements through three complementary data sources. First, an industry survey was conducted among consortium partners and ecosystem stakeholders to obtain first-hand insights into the competencies sought by energy-

sector employers. Second, a web-crawling and data analysis approach was used to collect and evaluate online job postings related to the energy transition and digital energy systems. Third, findings were benchmarked against existing studies and reports addressing workforce needs in the context of the digital energy transition, providing further validation of the identified trends.

The results of the analysis indicate a growing demand for hybrid professionals who combine strong engineering expertise with advanced digital competencies and well-developed transversal skills. In particular, the energy sector increasingly requires engineers capable of applying AI, data analytics, automation, and digital technologies within complex energy systems, while also demonstrating adaptability, interdisciplinary collaboration, communication, and problem-solving capabilities. These findings confirm the importance and strategic relevance of developing educational programmes that effectively bridge the gap between energy engineering and digital innovation.

Combining the results of the skill supply and demand analysis, four clear skill gaps are identified:

- **Digital thinking in energy systems**: typical energy problems are increasingly solved with digital solutions, as opposed to the traditional lectures and exercises taught in academia.
- **Broad AI literacy**: artificial intelligence is rapidly transforming the energy industry, and energy education should teach students how to exploit new tools in an efficient and responsible manner.
- **Specialised algorithm knowledge**: novel machine learning algorithms can unlock significant value by learning patterns from big datasets, but they require in-depth expertise to be applied properly.
- **Big data analytics**: the digitalisation of power systems has strongly increased the availability of energy data, and the processing of this information requires knowledge of data processing procedures.

These skill gaps provide the foundation for the AI4GreenDeal product strategy. By offering an innovative and versatile learning path, the proposed programme addresses current skill gaps and is robust to changes in future requirements. More concretely, the programme consists of the following elements:

- **Advanced Energy Systems and AI courses**: course lists from the previous master are updated to include data science and AI components.
- **Online stackable modules**: besides traditional courses, the programme also contains flexible online modules, which can be used to track digital developments more closely.
- **Innovation journey**: across the programme, students follow workshops at ESADE business school to train their soft skills and business intuition in the AI era of the energy sector.
- **Connection with industrial ecosystem**: students receive ample opportunities to connect with InnoEnergy ecosystem partners, allowing a smooth transition to a job in the energy sector.

Introduction

The European energy sector is currently facing major challenges of unprecedented complexity, spanning across multiple countries and pressuring each aspect of the energy trilemma. First, ongoing geopolitical conflicts, such as the Russian invasion of Ukraine and heightened tensions in the Strait of Hormuz, have negatively impacted fossil fuel prices, ultimately leading to higher electricity prices and a general decrease of energy affordability. Second, to achieve a climate-neutral European Union by 2050, all Member States must collectively invest into sustainable power systems, introducing additional technical challenges in the generation, transmission, and distribution of electricity. Third, the global trend towards increased electrification is threatening security of supply. The growing pressure on grid infrastructure has resulted in serious issues, such as the Iberian Peninsula blackout in April 2025, and severe congestion problems in the Netherlands.

In parallel to the energy transition, the rise of artificial intelligence has spurred a revolutionary digital transformation. On the one hand, AI technology and its associated data centres increase the load on power grids due to their substantial electricity consumption. On the other hand, AI is a key enabler of the digitalisation of power systems, which is a crucial part in the solution of Europe's current energy challenges. More specifically, AI methods allow a higher degree of automation in energy systems, lead to precise insights in large amounts of energy data and enable more optimal decision making. These technological advances reinforce the resilience of power systems, and they enable the broad rollout of clean renewable energy technologies, which benefits the climate goals of the Green Deal and relieves the dependency on external fossil fuels.

Current energy engineering education primarily focuses on traditional engineering competencies, including thermo-mechanical systems, electrical engineering, and related technical disciplines. However, the increasing digitalisation of the European energy sector is rapidly widening the gap between academic training and evolving industry requirements. In response to these developments, the AI4GreenDeal project aims to expand the scope of the existing *Energy for Smart Cities (EFSC)* master's programme by integrating data science and artificial intelligence competencies into the newly developed *Advanced Energy Systems and AI (AESAI)* programme.

To support this transformation, the present report provides a comprehensive analysis of the existing skills gaps within the current EFSC programme and outlines the product strategy underpinning the AESAI programme. The first section examines the supply side of the skills gap through an analysis of the current curriculum and course content. The second section addresses the demand side by identifying the competencies and qualifications increasingly required by the energy industry. This assessment is based on multiple data sources, including an industrial partner survey, web-based data mining of online job postings, and a review of relevant reports and studies published by recognised institutions.

Finally, the comparative analysis of educational supply and industry demand enables the identification of the most critical skills gaps. These findings serve as the foundation for the development and positioning of the AESAI programme, ensuring its alignment with emerging labour market needs and the broader objectives of the digital and green energy transition.

1 Academic Skills Offering

As a first step in the skills gap analysis, the current academic offering across all partner universities participating in the Energy for Smart Cities (EFSC) master's programme was examined in detail. Within the existing programme structure, KU

Leuven and KTH Royal Institute of Technology provide education throughout both years of the master's programme, while Universitat Politècnica de Catalunya and Grenoble INP - UGA contribute primarily to the second-year specialisation courses.

A detailed review of the course content enables a comprehensive assessment of the programme's existing strengths and academic focus areas, while also identifying potential weaknesses, gaps, and underrepresented competencies. This analysis provides valuable insight into the extent to which the current curriculum aligns with emerging industry demands and highlights areas where additional digital and AI-related competencies may be required.

Appendix A contains four tables that describe the curricula at each university. The columns correspond with the name of the course, its category, the number of learning credits (ECTS), and the course type (mandatory or elective). To support the subsequent analysis, there are four broad course categories: energy, AI and data science, a combination of AI and energy, and general engineering courses. The course lists are based on the course content of the EFSC master taught in academic year 2025–2026. As the transition towards the AESAI programme will start in academic year 2026–2027, the considered courses are the most recent representation of the learning content before the AI4GD project.

In the following two subsections, a closer look is taken at the energy-related courses in the current programmes, and the AI and data science elements that are already included are identified.

1.1 Current Energy Content

Energy engineering education can generally be categorised into three principal domains: electrical engineering, thermo-mechanical engineering, and energy economics. The current first-year partner universities, KU Leuven and KTH Royal Institute of Technology, provide students with a strong foundational understanding across these core areas.

Within the electrical engineering domain, students develop competencies in power systems, power electronics, electrical drives, and smart distribution systems. The thermo-mechanical component covers subjects such as thermal systems, renewable and nuclear energy technologies, and conventional combustion-based energy systems. In parallel, the programme addresses the economic and policy dimensions of the energy transition through courses focused on electricity markets, energy economics, and broader regulatory and political aspects of the energy landscape.

During the second year of the EFSC master's programme, students may specialise at any of the four partner universities. The second phase of the programme offers more advanced and specialised courses that build upon the broad interdisciplinary foundation established during the first year. In many cases, these advanced modules are closely aligned with the research expertise of the academic staff, ensuring that course content remains up to date and effectively bridges the gap between academic education and state-of-the-art research developments.

In addition to the advanced coursework, the second year includes a 30 ECTS master's thesis, which constitutes the capstone component of the programme. By nature, thesis projects address relevant and unresolved challenges, exposing students to contemporary research methodologies and requiring them to apply critical, analytical, and creative problem-solving skills. Several thesis projects are conducted in collaboration with industrial partners, providing students with valuable experience in addressing real-world challenges within the energy sector and strengthening the connection between academia and industry.

1.2 Current AI and Data Science Offering

Historically, energy engineering education has primarily focused on traditional engineering competencies, including power transfer principles, thermal systems, and conventional energy technologies. As a result, the fundamental courses delivered during the first year of the programme contain only limited digital content. In the most recent iteration of the EFSC curriculum, no dedicated first-year course was specifically focused on data science or artificial intelligence.

In contrast, AI- and data-related topics have gradually been introduced within the second year of the programme through elective and specialised courses. With the exception of KTH Royal Institute of Technology, all partner universities currently offer students opportunities to develop competencies in areas such as optimisation, machine learning, and data analytics. For instance, both KU Leuven and Universitat Politècnica de Catalunya provide courses addressing optimisation methods for energy systems, reflecting the growing importance of optimal generation dispatch and energy system management within increasingly complex electricity networks.

In addition to these applied modules, three of the four partner universities also offer more foundational courses focused on optimisation techniques and machine learning methodologies. Such competencies are becoming increasingly essential for addressing contemporary energy challenges through data-driven and AI-enabled approaches. Nevertheless, across the entire consortium, only a limited number of courses currently focus explicitly on AI and data science topics, highlighting that the programme is still in a transitional phase as it evolves in response to emerging trends and technological developments within the modern energy sector.

Furthermore, students may gain exposure to advanced data analytics and AI applications through their master's thesis projects, depending on the selected research topic. Since thesis topics are often defined in collaboration with research groups and industrial stakeholders, students are frequently introduced to state-of-the-art machine learning techniques, data processing methods, and digital tools during this phase of the programme. In its current form, this research-driven digital learning experience already provides significant added value for students' future professional careers and supports their ability to engage with increasingly digitalised energy systems.

2 Industry Requirements

This section examines the demand side of the skills gap within the energy sector by analysing the competencies and qualifications increasingly required from newly graduated energy engineers. To support this assessment, input data was collected from multiple complementary sources, including industrial partners, online job market analysis, and relevant sectoral and policy reports.

The findings from these sources provide a comprehensive overview of current labour market expectations and emerging trends within the rapidly evolving energy landscape. Based on this evidence, the subsequent subsections summarise both the present and anticipated future industry requirements, with particular attention to the growing importance of digital, AI-related, and interdisciplinary competencies in the energy sector.

2.1 Data Sources

The input data used to identify industry requirements was gathered through three complementary approaches: an industrial partner survey, a rigorous web-based data mining process, and a review of relevant reports related to employment trends and workforce needs within the energy sector. Together, these methods provide a comprehensive and evidence-based understanding of the competencies increasingly demanded by industry stakeholders.

The following subsections describe each of these methodologies in greater detail, outlining the data collection approaches, analytical methods, and their respective contributions to the overall skills gap assessment.

2.1.1 Industrial Partner Survey

Survey Structure and Respondents

To gain insight into the requirements of the energy sector from the perspective of employers, a survey was conducted between February and March 2026 to assess the desired qualifications and competencies for early-career energy engineers. Responses were collected during the same period from both industrial partners involved in the AI4GreenDeal project and organisations within InnoEnergy's broader ecosystem.

Table 1 presents an overview of the respondents, including their sector of activity and their relationship to the project. The participating organisations provide a reasonably diverse representation of the energy sector, encompassing companies active in areas such as consulting, energy trading, and technological services and support. Nevertheless, it should be acknowledged that the sample size remains relatively limited and may contain a degree of selection bias, as consortium members and InnoEnergy ecosystem partners are generally more engaged with innovation and AI adoption than the broader market. Consequently, the survey results should be interpreted primarily as indicative and directional insights rather than statistically representative conclusions.

The complete questionnaire is included in Appendix B. The survey began with questions addressing the background and profile of the participating organisations. Subsequent sections explored industry challenges and expectations related to generative AI, machine learning, and ongoing transformations within the energy sector. Additional questions assessed the perceived importance of transversal and soft skills for newly graduated professionals. Finally, respondents were invited to identify anticipated future trends within their domain and to provide recommendations regarding the future development of energy engineering education programmes.

***Table** 1: Survey respondents from the industrial partner survey*

#	Company	Sector	Role
1	**TokWise**	Portfolio management and trading	AI4GD Partner
2	**Geobeholder**	Critical raw materials exploration and geothermal energy	AI4GD Partner
3	**Ento**	Energy management technology	AI4GD Partner
4	**Watt-IS**	Data analytics in the energy sector	AI4GD Partner
5	**Pirelli**	Manufacturing (automotive)	InnoEnergy Ecosystem
6	**NTT DATA**	Tech consultancy	InnoEnergy Ecosystem
7	**Spacewell**	Energy management	InnoEnergy Ecosystem
8	**ABB**	Energy and automation	InnoEnergy Ecosystem

AI and Technology Adoption

Generative artificial intelligence has already had a substantial impact across the majority of participating companies, resulting in an average perceived impact score of 4 out of 5 among survey respondents. Most organisations reported the use of generative AI technologies, particularly large language models (LLMs), to automate and accelerate the generation of text, code, and analytical content. The primary advantage identified by respondents is the significant improvement in operational efficiency, enabling companies to save considerable time and resources. Across the surveyed organisations, LLMs have contributed to productivity gains in areas such as legislative analysis, preparation of commercial proposals, content generation, and administrative workflows.

The impact is particularly pronounced within software-oriented companies operating in the energy sector. Several respondents indicated that AI-driven automation is fundamentally changing the role of energy software engineers, shifting their responsibilities from direct implementation toward the supervision, validation, and orchestration of AI-enabled tools and systems. One company reported the development of an agentic AI energy analyst with advanced reasoning capabilities capable of performing tasks traditionally undertaken by experienced human analysts. Another software company explained that coding activities are increasingly automated through AI-assisted development tools, making strategic system design and problem definition more critical competencies than manual programming itself. These observations suggest an ongoing transformation in the skill profiles required within digital energy companies.

Half of the surveyed companies indicated that they are actively investing in employee training initiatives to keep pace with developments in generative AI technologies. These initiatives include workshops, facilitated access to emerging AI tools, internal training programmes, and participation in university-led micro-credential courses.

The survey also examined the impact of machine learning technologies more broadly, which have gained significant momentum in recent years. Respondents reported an average impact score of 3.5 out of 5 for machine learning applications. While approximately half of the companies indicated substantial benefits from these technologies, the remaining respondents reported more limited or indirect impacts.

Software companies again emerged as the primary beneficiaries of machine learning adoption. These organisations typically operate with agile and innovation-oriented teams, enabling faster adaptation to emerging technologies. Respondents highlighted the application of machine learning methods in areas such as electricity price forecasting, predictive maintenance, fault detection, and optimisation-driven decision support. To support these developments, energy software companies increasingly seek professionals who combine strong energy engineering expertise with competencies in artificial intelligence, data analytics, and machine learning.

Energy Sector Dynamics

Driven by widespread decarbonisation efforts, the electricity generation mix has undergone significant transformation across many regions, creating substantial implications throughout the entire energy value chain. Renewable energy sources offer a sustainable alternative to fossil fuel-based generation; however, their inherently variable and weather-dependent nature introduces additional complexity into power system operation and management. As a consequence, the growing integration of renewable energy has increased the need for system flexibility, balancing mechanisms, and demand response solutions, giving rise to new business opportunities within the energy sector.

Several respondents highlighted that the increasing variability of electricity generation contributes to greater volatility in electricity prices, thereby creating opportunities for advanced procurement, forecasting, and trading strategies. In parallel, the rising demand for system flexibility has strengthened the business case for energy storage technologies, benefiting companies involved in the development, installation, operation, and optimisation of storage systems. Across these emerging business domains, companies increasingly require engineers who possess a strong understanding of both the technical foundations of the energy transition and its broader operational and market implications.

At the same time, energy-related regulation and legislation continue to evolve rapidly in response to changing power system conditions and policy objectives. These regulatory developments frequently generate new market opportunities and require companies to adapt their operational strategies accordingly. One survey respondent noted that the transition from hourly to quarter-hourly day-ahead electricity pricing created the need for a major client project focused on redesigning energy trading strategies. Another respondent highlighted that stricter building energy efficiency regulations are driving increased demand for innovative energy-saving solutions and associated engineering services.

These developments demonstrate that the modern energy sector increasingly requires professionals who are capable of understanding not only the technical behaviour of energy systems, but also the evolving regulatory, economic, and market frameworks that shape the energy transition. Consequently, interdisciplinary competencies combining engineering, digital, economic, and regulatory knowledge are becoming essential for future energy engineers.

Soft Skills

Within the survey, five out of eight respondents indicated that recently graduated engineers often lack sufficiently developed soft skills when entering the labour market. **Table 2** summarises the transversal competencies that participating companies consider most valuable for early-career professionals, but which typically still require further development after graduation.

The increasing complexity of the energy transition, combined with the rapid emergence of AI-driven technologies and digital tools, further reinforces the importance of these soft skills. In highly dynamic and interdisciplinary working environments, employers increasingly value graduates who can effectively communicate, collaborate across domains, adapt to rapidly changing technologies, and approach complex problems with critical and creative thinking. Consequently, soft skills are becoming an essential complement to technical expertise in the profile of future energy engineers.

***Table** 2: Soft skills valued by industry for young energy engineering graduates*

Soft Skill	Explanation
Communication and presentation skills	In a business setting, engineers must work together efficiently, and this requires strong communication skills.
Adaptability and willingness to learn	With the quickly varying energy and AI landscape, good energy engineers need to be curious to stay up to date with recent developments.
Critical thinking and analytical reasoning	With the rise of generative AI models automating engineering and business tasks, a critical mindset combined with analytical insight is crucial.
Ownership and autonomy	The current pace of implementation requires employees to have a strong sense of autonomy.
Teamwork and cross-functional collaboration	Good energy engineers need to have strong technical knowledge, but they should be able to use these skills in a collaborative environment.

Recommendations for University Programmes

Based on the recommendations provided by the eight survey respondents, three principal conclusions can be identified regarding the competencies required from future energy engineers:

1. **Strong programming and software development competencies are increasingly essential**, particularly for graduates entering software-oriented companies within the energy sector. Respondents emphasised that graduates should demonstrate proficiency in at least one programming language — most commonly Python — in order to effectively implement, adapt, and evaluate modern AI and data-driven solutions.

2. **A critical and analytical mindset is becoming progressively more important** in the context of increasing AI adoption. As AI systems and automation tools are increasingly used to support operational and strategic decision-making, engineers must be capable of critically assessing the reliability, robustness, and trustworthiness of AI-generated outputs and automated processes.

3. **Multidisciplinary expertise represents a major competitive advantage for energy engineers.** Respondents highlighted that the combination of competencies in electrical engineering, thermo-mechanical systems, energy economics, artificial intelligence, and data science creates a highly valuable and differentiated professional profile. Engineers capable of integrating knowledge across these domains are expected to play a crucial role in addressing the complex challenges associated with the digital and green energy transition.

2.1.2 Web Data Mining

Methodology

An additional approach used to identify industry requirements involved the analysis of online job vacancies for relevant energy engineering roles. Through collaboration with TalentNeuron[1], the project team gained access to an AI-based labour market intelligence platform capable of performing automated web crawling and large-scale analysis of job postings across the energy sector.

For each identified vacancy, the platform analyses and extracts the associated skill requirements. In general, the algorithm generates a comprehensive list of competencies and assigns a proficiency level to each skill, categorised as Beginner, Intermediate, Advanced, or Expert. To maintain a focused and meaningful analysis, the present study considers only those competencies identified at the Expert level.

In a subsequent step, the extracted skill sets from all relevant vacancies were aggregated and synthesised to provide a concise overview of the competencies currently demanded from energy engineering graduates. Furthermore, the platform enables targeted searches based on specific job profiles, allowing for a more detailed analysis of skill requirements associated with particular types of energy-related positions.

The resulting skill categories demonstrate strong alignment with the European Skills, Competences, Qualifications and Occupations[2] (ESCO) classification framework, which provides a standardised European taxonomy for occupations, skills, and qualifications. This alignment further strengthens the consistency and relevance of the identified industry requirements within the broader European labour market context.

Results

Tables 3 to 6 present the skill requirements identified through the web crawling analysis for several relevant job profiles within the energy sector. The first two columns of each table list the retrieved competencies alongside a brief description, while the third column categorises the skills into three broad domains: energy-related skills, AI and digital skills, and general or transversal competencies. Each table focuses on a distinct professional profile in order to provide a representative

1 TalentNeuron is an AI-powered labour market intelligence platform. See https://www.talentneuron.com.

2 https://esco.ec.europa.eu/en

overview of competency requirements across different segments of the energy industry.

Table 3 summarises the key competencies associated with the role of a Data Analyst in the energy sector. As expected, this position requires a solid understanding of energy systems and processes to enable the interpretation and contextualisation of energy-related data. In addition to domain-specific expertise, the role demands strong digital competencies, including experience with data visualisation tools and proficiency in SQL, a widely used programming language for database management and data querying. Furthermore, employers place significant emphasis on analytical reasoning and problem-solving capabilities for this type of position.

Table 4 presents the principal skill requirements for an AI Engineer operating within the energy sector. This profile requires a strong technical and computational background, including broad knowledge of AI applications and programming expertise in at least one coding language. Python was identified as the most commonly preferred language due to its extensive ecosystem of machine learning libraries and relevance for energy-related software development. Similar to the Data Analyst profile, employers also highlighted the importance of analytical thinking and problem-solving skills.

Table 5 outlines the competencies required for the role of Business Development Manager within the energy industry. Although this position is not exclusively technical, it remains highly relevant to engineering graduates, as many transition into commercial, strategic, or innovation-oriented functions rather than purely research-focused roles. This profile requires a broad range of transversal competencies, including leadership, strategic thinking, stakeholder engagement, and advanced communication skills. At the same time, effective performance in this role also depends on a sound understanding of both energy systems and digital technologies.

Finally, **Table 6** provides an overview of the competencies associated with the role of Project Manager in the energy sector. In addition to a strong theoretical understanding of energy systems, employers value practical experience with real-world energy projects and implementation processes. Specific examples highlighted in the analysis include experience with environmental impact assessments and grid integration initiatives. The role also demands a broad set of managerial and interpersonal competencies, including leadership, coordination, communication, and project management skills.

Overall, the web crawling analysis confirms that the modern energy sector increasingly demands multidisciplinary professionals who combine strong technical expertise with digital competencies and well-developed soft skills.

***Table** 3: Required expert-level skills for a Data Analyst in the energy sector*

Skill	Description	Category
Energy Data Analytics	Analysing energy-related data to optimise performance and operational efficiency.	Energy
Perform Data Analysis	Analyse datasets to extract meaningful insights, patterns, and trends for decision-making.	AI
Data Visualisation Software	Using tools to create graphical representations of complex data.	AI
SQL	A standard programming language used to manage and manipulate relational databases.	AI
Solve Problems	Identifying, analysing, and resolving issues to ensure smooth operations.	General
Think Analytically	Breaking down complex information logically to solve problems effectively.	General

***Table** 4: Required expert-level skills for an AI Engineer in the energy sector*

Skill	Description	Category
Artificial Intelligence	Leveraging AI to optimise systems, enhance performance, and predict maintenance needs.	AI
Machine Learning Algorithms	Developing algorithms that enable machines to learn from data automatically.	AI
Python (Computer Programming)	Use the Python programming language to develop software, automate tasks, or analyse data.	AI
Solve Problems	Identifying, analysing, and resolving issues to ensure smooth operations.	General

Think Analytically	Breaking down complex information logically to solve problems effectively.	General

Table 5: Required expert-level skills for a Business Development Manager in the energy sector

Skill	Description	Category
Strategic Planning	Developing long-term strategies for growth, sustainability, and performance improvement in energy systems.	Energy
Apply Strategic Thinking	Developing long-term plans to achieve organisational objectives.	General
Build Business Relationships	Develop and maintain professional partnerships and networks.	General
Communication	Clearly and effectively conveying information to various audiences in both verbal and written forms.	General
Identify New Business Opportunities	Identifying opportunities for business growth and implementing strategies to expand market reach.	General
Lead a Team	Coordinating and motivating team members to achieve project goals.	General
Manage Contracts	Administer and oversee contract creation, compliance, and renewals.	General
Negotiation Skills	Reaching mutually beneficial agreements through discussion and compromise techniques.	General

Table 6: Required expert-level skills for an Energy Project Manager

Skill	Description	Category
Environmental Impact Assessment	Evaluating the potential environmental effects of projects to ensure sustainability and compliance.	Energy

Grid Storage Battery System Integration	Designing and implementing battery storage solutions that integrate seamlessly with electrical grids.	Energy
Strategic Planning	Developing long-term strategies for growth, sustainability, and performance improvement in energy systems.	Energy
Lead a Team	Coordinating and motivating team members to achieve project goals.	General
Manage a Team	Leading and coordinating team activities to meet goals effectively.	General
Project Management	Planning, executing, and overseeing projects to ensure timely and efficient completion.	General
Solve Problems	Identifying, analysing, and resolving issues to ensure smooth operations.	General
Task Management	Organising and prioritising tasks to meet deadlines and objectives.	General
Time Management	Managing time and resources effectively to meet deadlines and ensure project success.	General

2.1.3 Similar Reports

Both the evolving energy landscape and the rapid advancement of AI-driven digital technologies represent global transformations affecting a wide range of industries and economic sectors. Consequently, a substantial body of literature and policy analysis has emerged that provides valuable insights into the changing skill requirements associated with the green and digital transition. To complement the primary data sources used in this study, a selection of relevant international reports was analysed to further support the assessment of current and future industry needs.

The analysis first examines two reports specifically addressing the intersection between artificial intelligence and the energy sector, with a focus on the implications of digitalisation for energy systems and workforce requirements. This is followed by a review of two additional reports investigating the supply and demand dynamics of skills related to green and digital occupations. Finally, five broader reports addressing future labour market developments and the evolving nature of work were examined to contextualise the findings within wider global employment trends.

The report analysis was conducted through a systematic review of a curated selection of publications issued between 2024 and 2026 by recognised international organisations, institutions, and policy bodies. For each report, the analysis focused on identifying trends in workforce demand, emerging competency requirements, and evolving skill profiles within the energy and digital sectors, with particular attention given to AI-related and interdisciplinary competencies.

Reports on the synergy between energy and AI

In April 2025, the International Energy Agency (IEA) published the report Energy and AI to examine the growing interdependence between artificial intelligence technologies and the energy sector. The report highlights the transformative potential of AI in enabling innovation across energy systems, while simultaneously emphasising the strong dependence of AI development on reliable and scalable energy infrastructure. In particular, the IEA projects that electricity consumption from data centres is expected to more than double by 2030, underlining the increasingly critical relationship between digitalisation and energy supply.

The report concludes that unlocking the full potential of AI within the energy sector will require a new generation of professionals equipped with both advanced digital competencies and strong expertise in energy systems. Furthermore, the IEA survey, which included more than 190 energy companies, revealed that the proportion of energy-sector job postings requiring at least one digital skill increased by approximately 20% on average in both the United States and the United Kingdom. At the same time, only around half of surveyed employers considered job applicants sufficiently prepared to meet the growing demand for digital competencies. These findings provide further evidence of a structural skills gap emerging at the intersection of energy engineering and artificial intelligence.

Another highly relevant reference is the report Digitalisation and AI for Power System Transformation, published by the International Renewable Energy Agency (IRENA) to support Canada's G7 presidency in 2025. The report argues that the digitalisation of power systems is no longer optional, but rather a critical enabler of electrification, flexibility, and decarbonisation. IRENA identifies five primary areas in which digital technologies create added value for modern power systems: monitoring, forecasting, operational optimisation, end-use optimisation, and transparency. Together, these applications contribute to measurable improvements in system performance and resilience, further highlighting the growing importance of digital competencies within energy engineering professions.

As part of its analysis, IRENA also conducted a stakeholder survey, which found that 60% of respondents considered the shortage of skilled workers to be a critical or high-level barrier to the digitalisation of power systems. In response, the agency recommends substantial investment in workforce reskilling and upskilling initiatives focused on digital and AI-related competencies. The report further emphasises the importance of conducting comprehensive skills gap analyses in close collaboration with industry stakeholders to ensure that educational programmes remain aligned with the rapidly evolving demands of the energy transition.

Reports on skill sets in green and digital jobs

In 2024, LinkedIn published its Global Green Skills Report, based on anonymised labour market data from more than one billion users collected between January 2021 and July 2024. The report aims to provide insights into the global supply and demand dynamics for green skills, identify gaps in the green talent pipeline, and formulate recommendations for policymakers and educational institutions.

One of the report's central findings is that global demand for green skills increased at approximately twice the rate of the available supply of green talent between 2023 and 2024. Overall, demand for green skills grew by 11.6% during this period. Within the technology sector specifically, demand increased by approximately 60%, underscoring the rapidly growing need for hybrid professional profiles that combine digital competencies with sustainability and energy-related expertise. The report identifies sustainability management, sustainability reporting, energy efficiency, and product lifecycle management as among the most sought-after competencies driving this increase in demand.

A second relevant reference is the Training Supply for the Green and AI Transitions report published by the Organisation for Economic Co-operation and Development (OECD) in 2024. The report builds upon the findings of two policy questionnaires distributed among OECD member countries and evaluates whether current workforce training systems are sufficiently aligned with the rapidly evolving skill requirements associated with both the green and AI transitions.

The report concludes that training supply is currently insufficient to meet labour market demand in both domains. Regarding AI-related competencies, the OECD distinguishes between broad AI literacy skills required across the general workforce and more specialised technical competencies, including machine learning, neural networks, and advanced AI methodologies. This distinction closely aligns with the findings of the AI4GreenDeal industrial partner survey, which similarly identified a dual need: broad AI awareness for all future energy engineers, alongside advanced AI expertise for professionals working in specialised software and digital energy roles.

Furthermore, the OECD report highlights that integrated approaches combining green and AI upskilling remain relatively uncommon, despite their potential to provide a more holistic response to emerging labour market needs. This observation further emphasises the strategic relevance and distinctive positioning of the AI4GreenDeal project, which explicitly aims to combine advanced energy engineering education with AI and digital competencies within a single interdisciplinary programme

Reports on the general future of jobs

The 2025 edition of the Future of Jobs Report, published by the World Economic Forum (WEF), provides a comprehensive overview of evolving skill requirements and labour market transformations across the global economy. The report is based on survey responses from more than 1,000 employers representing 22 industry sectors and 55 economies worldwide.

According to the report, occupations related to artificial intelligence and big data currently represent the fastest-growing job categories globally. Simultaneously, driven by climate change mitigation policies and the accelerating energy transition, renewable energy engineers and environmental engineers are identified among the top 15 fastest-growing occupations. Consistent with findings from other analysed reports, the WEF identifies labour market skill gaps as the single largest barrier to business transformation, cited by 63% of surveyed employers.

To address these challenges, approximately 85% of employers indicated plans to invest in workforce upskilling and reskilling initiatives. Furthermore, in response to increasing labour market uncertainty and rapid technological change, employers increasingly value transversal competencies that enable adaptability and continuous learning. In particular, analytical thinking was identified as an essential competency by seven out of ten employers. Additional highly valued soft skills include resilience, flexibility, agility, leadership, and social influence.

Further evidence of the growing importance of AI competencies can be found in the Global Learning & Skills Trends Report 2026, published by Udemy Business. The report is based on proprietary learning analytics and user engagement data collected through the platform's global online training ecosystem. Its central conclusion is that AI fluency is rapidly becoming a core competency across virtually all sectors and organisational functions.

The report distinguishes between three progressive levels of AI capability development: foundational AI literacy at beginner level, workflow-integrated AI competencies at intermediate level, and advanced expertise involving the implementation and management of agentic AI systems at expert level. The findings demonstrate substantial growth in demand for AI-related training, illustrated by exceptional year-on-year increases in enrolment for courses related to tools such as GitHub Copilot and Microsoft Copilot.

In addition, the report suggests that highly interactive and practice-oriented learning formats, particularly those involving immediate feedback and applied exercises, can significantly improve learning effectiveness compared to traditional lecture-based approaches. Finally, the study reinforces the growing importance of complementary human-centred competencies, including critical thinking, resilience, adaptability, and the ability to operate effectively in complex and uncertain environments shaped by rapid technological change.

2.2 Current Requirements

Based on the findings from the industrial partner survey, the web crawling analysis, and the review of relevant international reports, the key industry requirements for future energy engineers can be synthesised as presented in **Table 7**. Similar to the previous analyses, these requirements are grouped into three overarching categories: energy-related competencies, AI and digital competencies, and general or transversal skills.

The most fundamental requirement identified by employers is a comprehensive understanding of the energy sector value chain and the functioning of modern energy systems. In addition, companies increasingly seek engineers capable of optimising energy flows through the analysis and processing of large-scale energy data, often supported by advanced optimisation techniques and digital tools. Another critical competency concerns knowledge of energy markets, regulatory frameworks, and policy mechanisms that shape the operation and evolution of the energy sector. Such expertise enables engineers to better understand rapidly changing market dynamics, support strategic decision-making, identify emerging business opportunities, and help organisations adapt to ongoing developments within the energy transition. Furthermore, employers increasingly value engineers with insight into the financial and economic dimensions of energy systems, including competencies related to long-term investment planning, sustainability assessment, and environmental impact analysis at organisational level.

With regard to AI and data science competencies, three major requirements clearly emerge from the analysis. First, all energy engineers are expected to possess a broad level of AI literacy. Generative AI technologies and large language models are increasingly considered essential professional tools that support productivity, accelerate workflows, and facilitate a broad range of analytical and administrative tasks. These technologies can assist engineers in analysing technical documentation, generating reports, and supporting software development processes related to digital energy systems.

Second, engineers working in software-oriented or highly digitalised energy environments are expected to demonstrate advanced expertise in machine learning and AI methodologies. This includes knowledge of neural networks for forecasting applications, reinforcement learning techniques for optimisation and control problems, and emerging agentic AI systems designed for autonomous task execution and decision support.

Third, the ongoing digitalisation of energy infrastructure has generated unprecedented volumes of operational and market-related data. Consequently, companies increasingly require professionals capable of effectively processing, managing, storing, and visualising large and complex datasets in ways that support actionable insights and informed decision-making.

Beyond technical competencies, employers also emphasise the growing importance of transversal and soft skills. As generative AI tools increasingly automate routine engineering tasks, analytical reasoning and critical thinking become essential to validate, interpret, and supervise AI-generated outputs. Moreover, the rapid pace of technological change within both the digital and energy transitions requires professionals who demonstrate adaptability, flexibility, and a willingness to continuously learn and evolve alongside emerging technologies. Communication, collaboration, and presentation skills also remain highly important, as engineers frequently operate in multidisciplinary teams and engage with a wide range of stakeholders across technical, managerial, and policy-oriented environments.

Importantly, employers do not primarily value these competency clusters in isolation. Rather, the highest demand exists for multidisciplinary professionals who successfully combine strong energy engineering expertise with advanced digital competencies and well-developed soft skills. Such hybrid profiles are particularly well positioned to address the complex and interconnected challenges of the green and digital transitions, leveraging AI-driven approaches alongside analytical, adaptable, and systems-oriented thinking.

***Table** 7: Summary of current industry requirements for energy engineering graduates*

Industry Requirement	Description	Category
Fundamental energy knowledge	Broad knowledge of the generation, transmission, distribution, and storage of energy.	Energy
Optimization of energy systems	Understanding energy flows and how to optimize them, potentially with the help of advanced (AI) algorithms.	Energy
Energy markets and energy policy	Insight into the structure of energy markets and their regulation, which allows to anticipate energy sector dynamics.	Energy
Financial analysis of energy systems	Analyzing the long-term financial and environmental impact of energy choices in a business context.	Energy
Digital thinking in energy systems	Analysing and tackling energy problems with state-of-the-art digital solutions.	Energy/AI
Broad AI literacy	Fluency with a broad range of AI tools that can speed up workflows, including text and code generation tools.	AI
Advanced algorithm knowledge	In-depth knowledge of machine learning and AI algorithms, and their applications in the energy sector.	AI
Big data analytics	Processing large datasets in a computationally efficient way, and knowing how to visualize them.	AI
Analytical and critical thinking	Breaking down complex information logically to solve problems effectively with a critical attitude.	General
Flexibility and adaptability	Quickly adapting to new technologies to achieve and maintain optimal workflows.	General
Communication and presentation skills	Clearly and effectively conveying information to various audiences in both verbal and written forms.	General

2.3 Future Trends

The previous sections provided an overview of current industry requirements and existing skills gaps within the energy sector. However, given the rapid pace of technological and societal transformation, it is equally important to anticipate future workforce needs and emerging competencies. Several recent international studies and policy reports provide valuable insights into how digitalisation, artificial intelligence, and the green transition are expected to reshape labour markets over the coming decades.

An analysis conducted for the European Commission on future employment trends (Petit, 2025) indicates that AI and digital technologies are expected to generate substantial employment growth across the European Union, particularly for highly skilled workers. Baseline projections suggest a 23% increase in high-skilled employment by 2040, reflecting the strong complementarities between advanced digital technologies and higher-level qualifications. Nevertheless, the report also identifies significant differences between European countries in terms of their projected labour market outcomes and capacity to benefit from digital transformation. While countries such as Spain, Ireland, and Hungary are expected to experience relatively strong employment gains, others, including Finland and Romania, may face more limited growth or even employment decline in specific sectors. These variations are partly linked to demographic trends, but are also strongly influenced by differences in digital readiness, innovation ecosystems, and the capacity to adapt to technological change. The report further notes that countries considered later adopters of digital technologies, including France and Italy, may require stronger digital integration and innovation policies to avoid exclusion from future technological and economic gains.

The analysis additionally highlights that young workers aged 15–24 are projected to experience declining employment opportunities across much of Europe. This trend is partly explained by the concentration of younger workers in lower-skilled occupations that are more vulnerable to automation, while others remain engaged in education and training during this age period. These findings reinforce the importance of equipping future graduates with advanced and adaptable competencies aligned with long-term labour market developments.

Similar differences in the pace and maturity of digital integration were also observed in the previous assessment of existing industry requirements. Countries with highly developed technology ecosystems, such as Sweden, often demonstrate stronger adoption of AI and digital innovation within the energy sector, whereas other regional ecosystems may progress more gradually. These national and regional differences should therefore be carefully considered in the design and implementation of the AESAI programme to ensure balanced, inclusive, and consistent skills development across all partner institutions.

Additional future-oriented insights are provided by the United Nations Regional Information Centre for Western Europe (UNRIC), which argues that human-centred competencies such as creativity, critical thinking, and complex problem-solving will become increasingly valuable in the AI era, as these skills remain difficult to fully automate or replicate technologically. At the same time, AI is expected to generate new employment opportunities in areas including digital technology development, AI governance and ethics, the green transition, and healthcare. These developments underline the growing importance of adapting educational systems and workforce training to enable societies to fully benefit from AI-driven transformation and automation.

Within the energy sector specifically, the International Energy Agency (IEA) projects that, under current policy trajectories, the number of energy sector graduates will need to increase by approximately 43% by 2030 to meet expected labour market demand (IEA, 2025). Over the coming decade, the strongest growth in demand is anticipated for workers with vocational education and training (VET) backgrounds, while highly specialised and technology-intensive positions are expected to require modular upskilling pathways and targeted on-the-job training initiatives.

Similarly, the 2025 Global AI Jobs Barometer published by PwC identifies an increasing need within the energy and utilities sector for professionals capable of combining sustainability expertise with advanced digital competencies. The report specifically highlights growing demand for skills related to programming, IT systems, creativity, and critical thinking. It further recommends that business leaders actively invest in workforce development strategies that enable employees to effectively leverage AI technologies and support broader enterprise-wide transformation initiatives.

Finally, it is important to acknowledge the persistent gender imbalance within both the energy engineering and AI sectors. A recent report by International Renewable

Energy Agency (IRENA) indicates that women currently account for only 32% of full-time positions within the renewable energy sector, while representation decreases further to 28% in STEM-related occupations, with little measurable improvement observed since 2019 (IRENA, 2025b). This structural imbalance risks further exacerbating existing workforce shortages and limiting diversity within future innovation ecosystems. In response, the AI4GreenDeal project intends to explore equity-oriented measures aimed at supporting broader accessibility, inclusiveness, and participation within the AESAI educational pathways.

3 Skill Gaps and Product Strategy

3.1 Identified Skill Gaps

Following the analysis of the current curriculum's skill supply and the comprehensive assessment of industry demand, the most critical skills gaps relevant to the AI4GreenDeal project can now be identified.

1. **Digital thinking in energy systems**

When comparing the energy-related competencies required by industry with the current academic offering, it becomes clear that many of the requested skills are already addressed within the existing curriculum. This is expected, as the current programme was originally designed to educate traditional energy engineers with strong foundations in core engineering disciplines. Most courses currently follow a conventional teaching format consisting of lectures combined with paper-based exercise sessions. However, real-world energy challenges increasingly require the use of digital tools and computational approaches. As a result, many companies are seeking engineers who are not only capable of analysing energy systems conceptually, but who can also translate these problems into computational models and implement solutions using advanced programming and digital technologies.

2. **Broad AI fluency**

Innovation in the field of artificial intelligence is progressing at an unprecedented pace, whereas academic curricula and course content are typically updated on an annual basis. To remain competitive, companies are often required to adopt and integrate emerging technologies as rapidly as possible. In contrast, higher education institutions tend to introduce and evaluate AI tools more cautiously and gradually. As a result, a growing gap can emerge between the speed of technological adoption in industry and the competencies currently developed within academic programmes, contributing to a mismatch between educational outcomes and evolving industrial requirements.

3. **Specialized algorithm knowledge**

As the energy sector continues to digitalise, companies are increasingly focused on optimising energy systems and operational processes through advanced computational methods. In recent years, machine learning approaches such as reinforcement learning and agentic AI have accelerated a new wave of automation, optimisation, and intelligent decision-making across a wide range of business applications. In contrast, within the current academic offering, optimisation and machine learning topics are still relatively limited in scope and are primarily available as elective courses during the second year of the master's programme. This creates a growing gap between the advanced digital competencies increasingly demanded by industry and the depth of AI-related expertise currently embedded within the curriculum.

4. **Big data analytics**

The increasing automation, digitalisation, and monitoring of energy systems have resulted in a rapid growth in the volume and complexity of energy-related data flows. To effectively manage and extract value from these large datasets, employers increasingly require energy engineers who are capable of handling big data environments and working proficiently with at least one programming language, most commonly Python. In contrast, traditional energy engineering curricula generally include limited exposure to coding-intensive projects, data processing tasks, and applied computational exercises. As a result, practical competencies related to programming, data analytics, and digital workflow implementation remain underrepresented, despite their growing importance within the modern energy sector.

3.2 Skill Gap Validation with Prospective, Current, and Graduated Students

In February 2026, the AI4GreenDeal project team organised the AI4GD Value Proposition Workshop (VPW) in Barcelona. Following the workshop, an extensive report was developed based on nine facilitated sessions involving prospective students, current EIT InnoEnergy master's students, and recent alumni across six independent discussion groups. The report provides a comprehensive evidence base regarding student expectations, programme positioning, trust-building factors, and enrolment journey considerations relevant to the future AESAI programme.

The workshop also created a valuable opportunity to gather direct insights into participants' perceived competencies, educational experiences, career expectations, and skill development needs. The following three sections analyse the feedback collected during these discussions and compare the findings with the skills gaps identified in the previous section.

3.2.1 Survey Structure and Respondents

Appendix C provides an overview of all 11 questions included in the PollEverywhere survey. The first three questions focused on establishing the respondent profile and background characteristics. The following two questions explored participants' perceptions regarding the existing skills gaps among graduates of EIT InnoEnergy master's programmes. Finally, the remaining six questions assessed respondents' self-perceived competencies across several domains, including AI and digital skills, energy-related knowledge, and general transversal competencies.

In total, 18 participants responded to the survey, including seven prospective students currently enrolled in bachelor's programmes, six students actively pursuing an InnoEnergy master's programme, and five recent alumni. As the workshop was organised at ESADE Business School in Barcelona, approximately half of the respondents were affiliated with Universitat Politècnica de Catalunya. Although the majority of participants were Spanish nationals, the workshop also attracted an internationally diverse group of respondents, including participants from India, Colombia, Portugal, Taiwan, Zimbabwe, Costa Rica, and Italy.

3.2.2 Insights per Question Type and Respondent Group

Table 8 presents the average self-assessment scores assigned by respondents across different skill areas, evaluated on a numerical scale from 1 to 5, where higher values indicate greater perceived proficiency. The table structure additionally enables comparison between the different respondent groups.

Overall, prospective students reported the lowest confidence levels across all assessed competencies. For subject areas that are strongly represented within the EFSC curriculum, such as renewable energy systems and energy market knowledge, a noticeable increase in confidence can be observed among current students and alumni. This progression illustrates the added educational value of the master's programme in developing domain-specific energy expertise. Regarding transversal and soft skills, respondents across all groups generally expressed relatively high confidence in their capabilities.

In contrast, the differences between respondent groups were less pronounced for digital and AI-related competencies, including machine learning knowledge and the use of large language models (LLMs) and coding tools. Across all participant categories, respondents identified the use of LLMs as the competency in which they felt most confident, reflecting the rapid and widespread adoption of generative AI technologies among younger generations and early-career professionals. However, for more advanced AI-related competencies, such as practical experience with machine learning methods and coding-based AI tools, respondents reported substantially lower confidence levels, with an overall average score of 2.7. These findings further reinforce the existence of a significant skills gap in advanced digital and AI competencies within the current educational landscape.

***Table** 8: Average self-rated scores by respondent group*

Question (scale 1–5)	Alumni (n=5)	Current students (n=6)	Prospective students (n=7)
Ability to use LLMs	3.8	4.2	2.9
Ability to use coding tools	2.8	3.3	2.4
Machine learning knowledge	2.8	2.8	2.3
Soft skills	4.4	4.5	4.0

Renewable energy knowledge	4.4	4.7	2.8
Energy markets & regulation	3.6	3.3	2.1

Table 9 summarises the responses to two open-ended survey questions, which allowed participants to interactively upvote contributions made by other respondents. The first question, presented on the left side of the table, explored which competencies respondents considered essential for energy engineers operating within today's increasingly digitalised environment. The results clearly highlight the growing importance of AI-related competencies, including programming skills and the ability to critically assess and validate AI-generated outputs.

The second question, presented on the right side of the table, focused on identifying skill areas that respondents believe should receive greater emphasis within InnoEnergy master's programmes. A key finding from the responses is the strong value participants place on closer connections with industry and practical exposure to real-world applications. In addition, the results further underscore the importance of transversal competencies, particularly communication skills, teamwork, and collaborative problem-solving through case-based learning approaches.

***Table** 9: Top 5 responses to open poll questions (net upvotes)*

#	Essential skills for energy–AI–data engineer	Votes	#	Skills to emphasise more in InnoEnergy master's	Votes
1	Prompt engineering	5	**1**	Industrial networking	8
2	Coding	4	**2**	Multidisciplinarity	7
3	Critical thinking	3	**3**	Use case solving	6
4	Analysis of AI outcome	2	**4**	Industry exposure	5
5	Data analytics	2	**5**	Communication	5

3.2.3 Comparison with Identified Skill Gaps

The survey conducted among prospective students, current students, and alumni has provided an additional perspective on the existing skills gaps within the energy sector. The quantitative assessment of self-perceived competencies revealed that young energy graduates generally feel underprepared in advanced digital domains, particularly in areas such as machine learning and the use of integrated coding tools. These findings directly reinforce the previously identified skills gap related to advanced algorithmic and AI-related expertise.

Furthermore, the responses to the open-ended questions confirmed the growing importance of digital competencies for future energy and AI professionals. Participants highlighted not only technical skills such as programming and prompt engineering, but also the importance of critical thinking skills required to evaluate, interpret, and validate AI-generated outputs responsibly.

Beyond digital competencies, respondents also strongly emphasised the importance of stronger industry engagement within educational programmes, enabling students to develop practical and professionally relevant skills through real-world applications and collaboration with industry stakeholders. These observations are closely aligned with the previously identified skills gaps, particularly regarding the need for applied digital competencies and practice-oriented learning approaches within modern energy engineering education.

3.3 Product Strategy

The product strategy of the AI4GreenDeal project has been developed in close alignment with key European policy priorities supporting the green and digital transitions. In particular, the initiative contributes to the objectives of the European Green Deal by supporting the development of competencies required for a climate-neutral, resilient, and resource-efficient economy. At the same time, the programme aligns with the European Skills Agenda, which highlights the growing importance of workforce upskilling and reskilling in response to accelerating technological change, including the increasing relevance of digital and AI-related competencies.

Furthermore, the programme design incorporates key principles of the Bologna Process, including transparency, modularisation, flexibility, and learner-centred education within higher education systems. The integration of stackable online learning modules and interdisciplinary educational pathways reflects these principles while also supporting broader accessibility, flexibility, and lifelong learning opportunities across Europe.

Within this broader policy context, the AI4GreenDeal learning offer aims to contribute in a targeted, practical, and future-oriented manner to ongoing European efforts to strengthen the workforce capabilities required to successfully address the twin green and digital transitions.

3.3.1 Objective and Positioning

The AI4GreenDeal project directly addresses the growing shortage of professionals capable of operating at the intersection of advanced energy systems and digital technologies. The findings of this skills gap analysis confirm that, while strong energy engineering expertise remains a fundamental requirement, a significant “digital gap” persists within existing educational pathways.

Rather than adopting a broad generalist approach, the AESAI Master’s programme and the associated Online Stackable Modules are strategically positioned as a targeted and practical response to this mismatch between academic provision and labour market needs. The programme strategy focuses on combining deep energy engineering expertise with advanced competencies in artificial intelligence, data science, and digital technologies.

This dual-track educational model enables the project to simultaneously educate a new generation of degree-seeking students while also providing flexible upskilling and reskilling opportunities for professionals already active within the workforce. By closely leveraging the InnoEnergy ecosystem and its network of industrial stakeholders, the programme ensures that its educational content and competency focus remain strongly aligned with real market needs and emerging industry developments, rather than being driven solely by academic considerations.

3.3.2 Design Approach and Methodology

The programme design builds upon the combined expertise of the consortium partners and moves beyond traditional theoretical instruction towards a more applied, competency-based educational framework. The overall approach is structured around four core pillars:

1. **Embedded Digital Tools**
   AI and data-driven methods are not treated as isolated or standalone topics. Instead, digital technologies are integrated directly into energy engineering

courses, enabling students to apply AI and data tools to the analysis and solution of real-world energy challenges.

2. **Tiered Competency Development:** The programme adopts a layered competency model that begins with foundational AI literacy for all students and subsequently branches into more specialised learning pathways. This approach recognises that while all future energy engineers require a general understanding of AI technologies and digital workflows, only a subset of learners will need to develop advanced expertise in algorithm development and machine learning methodologies.

3. **Applied and Practice-Oriented Learning:** The educational approach prioritises project-based and challenge-based learning using real-world datasets and practical case studies. Particular emphasis is placed on developing “digital thinking” competencies, enabling students to translate engineering problems into computational and data-driven solutions applicable within modern energy systems.

4. **Soft Skill and Leadership Development:** Technical expertise alone is considered insufficient to address the complex challenges of the green and digital transitions. Through dedicated modules delivered in collaboration with ESADE Business School, the programme incorporates training in teamwork, leadership, negotiation, change management, communication, and design thinking. These competencies are developed through interactive and challenge-based learning formats designed to reflect real professional and multidisciplinary working environments.

3.3.3 Programme Components

The AI4GreenDeal learning offer is structured into three mutually reinforcing components designed to maximize European outreach and impact.

Master’s in Advanced Energy Systems and AI (AESAI)

As the core academic component of the AI4GreenDeal learning offer, the AESAI Master’s programme combines a strong foundation in energy engineering with specialised training in artificial intelligence and data science. The two-year programme structure is designed to support a progressive learning pathway, enabling students to transition from fundamental theoretical principles towards advanced, sector-specific applications within modern energy systems.

Online Stackable Courses & Micro-credentials

To support the European Union's strategic priority on lifelong learning, the AI4GreenDeal project will deliver approximately 238 hours of online learning content. These modules are designed as stackable educational components that will be integrated into the AESAI Master's programme and followed independently by professionals seeking targeted upskilling or reskilling opportunities. This modular approach aligns closely with the European framework for micro-credentials, enabling flexible, accessible, and learner-centred education pathways that can be adapted to the needs and schedules of an active workforce.

Innovation and Industry Engagement

Leveraging the InnoEnergy ecosystem, the program maintains a structural link to the market. This includes direct involvement from industry practitioners and the integration of entrepreneurship perspectives, ensuring the curriculum evolves in lockstep with technological breakthroughs and market trends.

3.3.4 Alignment with Identified Skill Gaps

The AESAI curriculum has been directly mapped against the skills gaps identified through the industry analysis. As a result, the programme strategy has moved beyond a traditional "generalist" engineering approach towards a more targeted educational model focused on addressing the specific technical and digital competency gaps highlighted by industrial stakeholders, as illustrated in **Table 10.**

At present, the first year of the EFSC programme, delivered by KU Leuven and KTH Royal Institute of Technology, contains only a limited number of ECTS credits dedicated to digital and AI-related content. With the transition towards the AESAI programme in the 2026–2027 academic year, the digital course offering during the first year is expected to increase substantially across all partner universities. This planned expansion reflects a significant strengthening of AI, data science, and digital competencies within the foundational phase of the programme.

Table 10: Alignment of identified skill gaps with AI4GreenDeal strategic responses

Identified Skill Gap	AI4GreenDeal Strategic Response
Digital Thinking	Shift from paper-based exercises to computational problem-solving and energy analysis with a programming component.
Broad AI Fluency	Implementing a modular update system to keep pace with rapid AI innovation, ensuring graduates stay ahead of the technology curve.
Specialized Algorithms	Transitioning Optimization and Machine Learning (e.g., Reinforcement Learning/Agentic AI) from niche electives to core competencies.
Big Data Analytics	Integrating Python-based data processing and coding projects into the foundational energy curriculum.

3.3.5 Expected Contribution

The AI4GreenDeal product strategy is expected to substantially improve the alignment between European higher education provision and the evolving labour market needs of the energy sector.

By educating graduates with balanced and multidisciplinary competency profiles, the project contributes to strengthening the European Higher Education Area (EHEA) while simultaneously supporting the broader objectives of the European Green Deal. Furthermore, the stackable and flexible structure of the online learning modules ensures that the project's impact extends beyond traditional degree-seeking students, contributing to the development of a more resilient, adaptable, and digitally competent workforce across Europe.

Although no single initiative can fully eliminate the growing skills gap associated with the green and digital transitions, AI4GreenDeal represents a structured, scalable, and future-oriented contribution towards strengthening Europe's capacity to maintain global leadership in the sustainable energy transition.

4 Conclusion

This report has presented a comprehensive analysis of the skills gaps between current energy engineering education and the rapidly evolving needs of the European energy sector. The supply side was assessed through a detailed mapping of the existing Energy for Smart Cities (EFSC) curriculum across the four partner universities, while the demand side was examined through an industrial partner survey, a web-based labour market analysis, and a review of relevant international sector reports. The combined findings demonstrate that current energy engineering education continues to provide a strong foundation in traditional disciplines such as electrical power systems, thermo-mechanical engineering, and energy economics. However, as the energy sector undergoes an accelerated digital transformation, the gap between academic provision and industry requirements is becoming increasingly pronounced.

Four priority skills gaps were identified as particularly relevant for the AI4GreenDeal project. First, a gap in digital thinking within energy systems reflects the disconnect between the largely theoretical framing of energy problems in academia and the increasingly computational, data-driven approaches used in industry. Second, graduates often enter the workforce with insufficient broad AI literacy, despite the fact that generative AI tools are rapidly becoming integral to professional workflows across the energy value chain. Third, advanced algorithmic competencies, including machine learning methods such as reinforcement learning and agentic AI, remain limited to a small number of elective courses, although these capabilities are increasingly considered core competencies by employers. Fourth, competencies related to big data analytics — including the processing, management, and visualisation of large-scale energy datasets using tools such as Python and SQL — are largely absent from the foundational curriculum.

These findings were further validated through a survey conducted with prospective students, current students, and alumni of InnoEnergy master's programmes. The results confirmed that respondents perceive themselves as significantly less proficient in advanced digital and AI-related competencies compared to traditional energy engineering domains. Participants also consistently highlighted the importance of stronger industry engagement, practical applications, and interdisciplinary learning experiences within higher education programmes.

In response to these identified challenges, the AI4GreenDeal project has developed a targeted educational and product strategy centred on the new Advanced Energy Systems and AI (AESAI) master's programme. A key objective of the programme is the direct integration of AI and data science competencies within energy engineering courses, ensuring that digital thinking becomes an embedded component of students' engineering education rather than a separate specialisation. In addition, the programme is complemented by approximately 238 hours of stackable online learning modules designed to support lifelong learning, flexible upskilling, and professional reskilling opportunities.

To address the transversal competencies consistently highlighted by industry stakeholders, the programme also incorporates an innovation and soft skills learning pathway delivered in collaboration with ESADE Business School. This component focuses on critical thinking, communication, adaptability, leadership, negotiation, change management, and design thinking. Furthermore, close collaboration with the InnoEnergy ecosystem ensures that the curriculum remains continuously aligned with market developments and enables students to benefit from direct exposure to industrial stakeholders and potential employers.

The urgency of this educational transformation is reinforced by broader international labour market projections. Reports published by the International Energy Agency (IEA), International Renewable Energy Agency (IRENA), World Economic Forum (WEF), and the Organisation for Economic Co-operation and Development (OECD) all point towards a structural and growing shortage of professionals capable of combining energy expertise with digital and AI-related competencies. Demand for green and digital skills continues to outpace available talent supply, AI-related occupations are among the fastest-growing job categories globally, and the proportion of energy-sector vacancies requiring digital competencies continues to increase year after year. Without targeted intervention at the level of higher education and workforce development, this gap is expected to widen further, potentially limiting both European competitiveness and the pace of the energy transition.

Within this context, the AI4GreenDeal project is positioned to make a meaningful and scalable contribution towards addressing these challenges. By educating a new generation of multidisciplinary engineers who are equally proficient in energy systems and digital technologies, the project directly contributes to the objectives of the European Green Deal, the European Skills Agenda, and the broader twin green and digital transition. The findings and strategic directions presented in this report provide the evidence base for the subsequent curriculum development activities of the project.

Based on the analysis conducted throughout this report, the following priorities are recommended for the design and implementation of the AESAI curriculum:

- Embed Python-based data processing and computational approaches throughout foundational energy engineering courses to address the identified big data analytics gap.
- Elevate machine learning, optimisation, and agentic AI topics from elective status to core curriculum components.
- Introduce a structured AI literacy module to establish a common foundational level of AI understanding across all partner institutions.
- Integrate ESADE-led soft skills and innovation workshops throughout both years of the programme, focusing on leadership, negotiation, change management, communication, and design thinking.
- Establish a modular and regularly updated framework for online stackable courses to ensure alignment with the rapid evolution of AI technologies and digital tools.

References

IEA. (2025). *Energy and AI*. Paris: International Energy Agency. Retrieved from https://iea.blob.core.windows.net/assets/601eaec9-ba91-4623-819b-4ded331ec9e8/EnergyandAI.pdf

IEA. (2025). *World Energy Employment*. International Energy Agency.

IRENA. (2025a). *Digitalisation and AI for power system transformation: Perspectives for the G7*. Abu Dhabi: International Renewable Energy Agency.

IRENA. (2025b). *Renewable Energy: A Gender Perspective, 2nd Edition*. Abu Dhabi: International Renewable Energy Agency.

LinkedIn. (2024). *Global Green Skills Report 2024*. LinkedIn.

OECD. (2024). *Training Supply for the Green and AI Transitions: Equipping Workers with the Right Skills*. Paris: OECD Publishing. Retrieved from https://doi.org/10.1787/7600d16d-en

Petit, F. (2025). *The future employment impact of artificial intelligence and emerging digital technologies in Europe*. European Commission.

PwC. (2025). *The Fearless Future: 2025 Global AI Jobs Barometer*. PwC. Retrieved from https://www.pwc.com/gx/en/services/ai/ai-jobs-barometer.html

Udemy. (2026). *2026 Global Learning & Skills Trends Report: Navigating transformational change in the era of AI and beyond*. Udemy Business.

UNRIC. (2025). *Artificial intelligence and the future of work: Disruptions and opportunities*. United Nations Regional Information Centre for Western Union. Retrieved from https://unric.org/en/ai-and-the-future-of-work-disruptions-and-opportunities/

WEF. (2025). *Future of Jobs Report 2025*. Geneva: World Economic Forum.

Appendices

A Curriculum Overview by University

This section contains a complete overview of all courses taught in the Energy for Smart Cities programme in academic year 2025-2026, for each partner university.

KTH Royal Institute of Technology (Sweden)

KTH Stockholm currently provides courses in both years of the master's programme as can be found for Year 1 in **Table** 11 and for Year 2 in **Table** 12. With courses such as Energy Demand and Supply Distribution Systems in Built Environment, City Networks in a Regional Context, and Sustainable Buildings, they bring strong expertise in the area of smart cities.

***Table** 11: KTH Royal Institute of Technology – Year 1 curriculum overview*

Course Name	ECTS	Type	Category
Power System Analysis	6	Mandatory	Energy
Power Electronics	6	Mandatory	Energy
Smart Cities and Climate Mitigation Strategies	9	Mandatory	Energy
Transdisciplinary Approaches for System Innovations	7.5	Mandatory	Energy
Heating, Cooling and Indoor Climate	6	Mandatory	Energy
FACTS and HVDC in Electric Power Systems	7.5	Cond. Elective	Energy
Innovation & Entrepreneurship in Electric Power Engineering	6	Elective	Energy
Electrical Machines and Drives	6	Elective	Energy
Renewable Energy Technology	6	Elective	Energy
Waste Management	7.5	Elective	Energy

Environmental Management	7.5	Elective	Energy
Power System Stability and Control	7.5	Elective	Energy
Communication and Control in Electric Power Systems	7.5	Elective	Energy
Electricity Market Analysis	7.5	Elective	Energy
Control in Electrical Energy Conversion	6	Elective	Energy
Introduction to Energy Systems Analysis and Applications	6	Elective	Energy
Energy Demand and Supply Distribution Systems in Built Environment	6	Elective	Energy
Project Management: Leadership and Control	6	Elective	General
Urban Economics and Cost Benefit Analysis	7.5	Elective	General
Leading People and Organizations in Different Contexts	6	Elective	General

***Table** 12: KTH Royal Institute of Technology – Year 2 curriculum overview*

Course Name	ECTS	Type	Category
Degree Project / Master's Thesis	30	Mandatory	Energy
Smart Cities and Climate Mitigation Strategies – Project Based	7.5	Mandatory	Energy
Innovation & Entrepreneurship in Electric Power Engineering	6	Mandatory	Energy
Sustainable Buildings - Concept, Design, Construction and Operation	7.5	Elective	Energy
Environmental Aspects of the Built Environment	7.5	Elective	Energy
Electrical Machines and Drives	6	Elective	Energy
Introduction Industrial Ecology	7.5	Elective	Energy
City Networks in Regional Contexts	7.5	Elective	General
Transport Data Collection and Analysis	7.5	Elective	General

Management of Projects	7.5	Elective	General

KU Leuven (Belgium)

KU Leuven also teaches courses in both years of the master's programme. In addition to their experienced power systems research group, they are also geographically close to offshore wind hubs in the North Sea that require strong connections with the mainland power system. Hence, their specialized knowledge is mostly in the area of smart and flexible power systems shown in **Table** 13 for Year 1 and **Table** 14 for Year 2.

***Table** 13: KU Leuven – Year 1 curriculum overview*

Course Name	ECTS	Type	Category
Power Systems	3	Mandatory	Energy
Power Electronics	3	Mandatory	Energy
Power System Calculations	3	Mandatory	Energy
Energy Markets and Regulation	3	Mandatory	Energy
Energy Economics	3	Mandatory	Energy
Smart Distribution Systems	3	Mandatory	Energy
Hands-on Project on Innovative Energy Systems, Part 1	3	Mandatory	Energy
Hands-on Project on Innovative Energy Systems, Part 2	3	Mandatory	Energy
Numerical Methods in Energy Sciences	6	Mandatory	Energy
Nuclear Energy: Basic Aspects	4	Mandatory	Energy
Combustion Engines	4	Mandatory	Energy
Renewable Energy	6	Mandatory	Energy
Electrical Drives; Energy Efficiency of Electrical Machines	4	Mandatory	Energy
Thermal Systems: Basic Aspects	3	Mandatory	Energy

Energy Challenges	3	Mandatory	Energy
Technology Entrepreneurship and New Business Development	6	Mandatory	General

Table 14: KU Leuven – Year 2 curriculum overview

Course Name	ECTS	Type	Category
Master's Thesis	30	Mandatory	Energy
Design and Management of Electric Power Systems	6	Elective	Energy
Electromobility	3	Elective	Energy
Electromagnetic Processing of Materials	3	Elective	Energy
Measurement and Testing, including High Voltages	3	Elective	Energy
Light and Lighting Systems	3	Elective	Energy
Materials in Electrical Engineering	3	Elective	Energy
Flexible Electrical Power Systems	3	Elective	Energy
Electrical Energy Conversion for Renewable Energy and Storage	3	Elective	Energy
Aerodynamics	6	Elective	Energy
Numerical Techniques in Fluid Dynamics	3	Elective	Energy
Turbulence	3	Elective	Energy
Aircraft Engines	5	Elective	Energy
Two-Phase Flow: Theory and Applications	3	Elective	Energy
Advanced Measurement Techniques in Fluid Mechanics	3	Elective	Energy
Turbomachinery, Part 2	3	Elective	Energy
Advanced Thermodynamics and Plasma Physics	6	Elective	Energy
Environmental Economics	3	Elective	Energy
Energy Law	4	Elective	Energy

Electricity and Gas Markets	3	Elective	Energy
Building Simulations, Part 1	3	Elective	Energy
Optimization Problems in Energy Systems	3	Elective	Energy/AI
Optimization	6	Elective	AI and Data Science
Experimental Design	4	Elective	AI and Data Science
Statistical Data Analysis	6	Elective	AI and Data Science
Fundamentals of Financial Mathematics	4	Elective	General
Industrial Automation and Control	6	Elective	General
Quantum Physics	3	Elective	General
Measurement Systems	3	Elective	General
Mechatronic Drive Systems	3	Elective	General
Innovation Management and Strategy	6	Elective	General
Philosophy of Technology	4	Elective	General
Engineering Economy	3	Elective	General
Management and Information Technology	3	Elective	General
ICT Service Management	6	Elective	General
Introduction to Management and Strategy	4	Elective	General
Ecodesign and Life Cycle Engineering	3	Elective	General
Intellectual Property Management	4	Elective	General
Project Management	3	Elective	General
Capita Selecta Smart Cities II.1.	3	Elective	General

Grenoble Institute of Technology / INP (France)

In the current programme, Grenoble INP offers courses in the second year of the master (**Table** 15). As their energy department has good relations with large industrial players, they can bring unique insights in applications at the end of the energy value chain, including large loads and data centres.

***Table** 15: Grenoble Institute of Technology (INP) – Year 2 curriculum overview*

Course Name	ECTS	Type	Category
Master's Thesis	30	Mandatory	Energy
ICT for Smart Grids and Smart Cities	5	Mandatory	Energy
Smart Energy Systems, Methods, and Tools	3	Mandatory	Energy
Design Models for Power Electronics	5	Mandatory (Major 1)	Energy
Power Electronics Semiconductor Devices	5	Mandatory (Major 1)	Energy
Power Electronics Project	5	Elective (Major 1)	Energy
Research Project	5	Elective (Major 1)	Energy
Energy Markets and New Stakeholders	5	Mandatory (Major 2)	Energy
Distributed Generation	5	Mandatory (Major 2)	Energy
Modelling and Operation of Electrical Grids	5	Elective (Major 2-1)	Energy
MicroGrids, SmartGrids and SuperGrids	5	Elective (Major 2-1)	Energy
Energy Management and Energy Efficiency of Buildings	5	Elective (Major 2-2)	Energy
New Sustainable Technologies	5	Elective (Major 2-3)	Energy
Machine Learning and Optimization	5	Elective (Major 1)	AI and Data Science
Overall Multidisciplinary Project	5	Elective (Major 2-2/3)	General
French Language	2	Mandatory	General

Universitat Politècnica de Catalunya / UPC (Spain)

In the current setup, UPC Barcelona teaches courses in the second year of the programme (**Table** 16). The combination of their expertise in low voltage systems, and the omnipresent photovoltaic installations in Spain places UPC in a unique position to teach about smart control strategies in distribution systems.

***Table** 16: Universitat Politècnica de Catalunya (UPC) – Year 2 curriculum overview*

Course Name	ECTS	Type	Category
Master's Thesis	30	Mandatory	Energy
Control and Automation for the Efficient Use of Energy	5	Core Elective	Energy
Energy Storage	5	Core Elective	Energy
Smart Grids	5	Core Elective	Energy
Advanced Course on Heat and Mass Transfer	5	Elective	Energy
Biogas and Biofuels	5	Elective	Energy
Computational Methods in Energy Technology	5	Elective	Energy
Electric Energy Conversion	5	Elective	Energy
Energy Economy and Comprehensive Energy Planning Models	5	Elective	Energy
Energy, Technology and Society	5	Elective	Energy
Experimental Energy Technology	5	Elective	Energy
Heat Exchange	5	Elective	Energy
Hydrogen and Fuel Cells	5	Elective	Energy
Integration of Renewables in the Electric Grid	5	Elective	Energy
Photovoltaic Solar Energy	5	Elective	Energy

Power Electronics and Electrical Machines Application in Electrical Mobility	5	Elective	Energy
Power Quality	5	Elective	Energy
Solar Photovoltaics	5	Elective	Energy
Solar Thermal Energy	5	Elective	Energy
Thermal Equipment Generating Heat and Cold	5	Elective	Energy
Turbulence: Phenomenology, Simulation, Aerodynamics	5	Elective	Energy
Power Electronics Applied to Distributed Resources	5	Elective	Energy
Wind Power	5	Elective	Energy
Data Science Applied to Electrical Energy Systems	5	Core Elective	Energy/AI
Energy Management and Optimization of Electrical Power Systems	5	Elective	Energy/AI
Challenge Based Module	5	Elective	General

B Industrial Partner Survey

Table 17 contains the questions that were used in the industrial partner survey, which is an important input for analysing industry requirements for energy engineers.

***Table** 17: Industrial partner survey questionnaire*

#	Question	Theme	Type
Q1	What's the name of your company?	Context	Open
Q2	In what sector or field would you place your company?	Context	Open
Q3	Please give a short description of the business model of your company, including core stakeholders, revenue streams and expenditures.	Context	Open

Q4	On a scale of 1–5, how much has your workflow been affected by the rise of generative AI?	GenAI Adoption	Scale (1–5)
Q5	If applicable, please provide an example of how genAI influences your workflow.	GenAI Adoption	Open
Q6	Did you train your employees to adapt to this technology?	GenAI Adoption	Yes / No
Q7	If applicable, how did you train your employees to adapt to this technology?	GenAI Adoption	Open
Q8	On a scale of 1–5, how much has your workflow been affected by recent advances in machine learning?	ML Adoption	Scale (1–5)
Q9	If applicable, please provide an example of how you implemented machine learning algorithms or applications in your workflow.	ML Adoption	Open
Q10	How did you train your staff to gain machine learning knowledge?	ML Adoption	Open
Q11	On a scale of 1–5, how much has your business model been affected by recent changes in the energy mix?	Energy Dynamics	Scale (1–5)
Q12	If applicable, give an example of a business opportunity created by recent developments in renewable energy technologies.	Energy Dynamics	Open
Q13	On a scale of 1–5, how much has your business model been affected by recent changes in energy markets or regulation?	Energy Dynamics	Scale (1–5)
Q14	If applicable, give an example of a change in energy markets or regulation that has impacted your workflow.	Energy Dynamics	Open
Q15	How do you keep your staff up-to-date with the latest trends in energy markets and regulation?	Energy Dynamics	Open
Q16	Do you think that recent graduates typically have sufficient soft skills?	Skills & Talent	Yes / No
Q17	What are the top 5 most important soft skills to succeed in your field?	Skills & Talent	Open

Q18	Do you provide trainings to continuously develop the soft skills of your employees? If so, what kind of trainings?	Skills & Talent	Open
Q19	What technical skills do you need in your day-to-day work that graduates typically lack when they enter the workforce?	Skills & Talent	Open
Q20	Do you observe a clear technological trend in your domain? If so, please describe the main challenges associated with this trend.	Tech Trends	Open
Q21	Do you think AI will be integrated even more in your organisation? If so, in what areas do you see the largest potential?	Tech Trends	Open
Q22	In the near future, what will be the most valuable technical skill(s) in your field?	Future Skills	Open
Q23	In the near future, what will be the most valuable soft skill(s) in your field?	Future Skills	Open
Q24	From your perspective, which skills should be integrated into university programs to better prepare graduates for industry roles?	University Recs	Open
Q25	If you would like to address any other current or future challenge in your domain, or a pressing skill gap between industry and academia, please let us know.	Other	Open

C Skill Gaps Validation Survey

Table 18 shows the questions of the survey that was presented to participants of the value proposition workshop in ESADE, Barcelona. The responses are useful to cross-check the identified skill gaps in the report.

***Table** 18: Questions for the skills gap validation survey with (prospective) students and alumni*

#	Question	Theme	Type
Q1	What's your relation to InnoEnergy?	Context	Multiple choice

Q2	What's your home university?	Context	Open
Q3	What's your nationality?	Context	Open
Q4	What skills are essential for an energy – AI – data science engineer in this day and age?	Skills & Talent	Open
Q5	How would you rate your ability to use LLMs?	AI & Digital Skills	Scale (1–5)
Q6	How would you rate your skill level of using coding tools like Claude Code and Lovable (vibe coding)?	AI & Digital Skills	Scale (1–5)
Q7	How would you rate your machine learning knowledge?	AI & Digital Skills	Scale (1–5)
Q8	How would you rate your soft skills (presenting, networking, writing)?	Soft Skills	Scale (1–5)
Q9	How would you rate your knowledge about renewable energy technologies?	Energy Knowledge	Scale (1–5)
Q10	How would you rate your knowledge about energy markets and regulation?	Energy Knowledge	Scale (1–5)
Q11	What skills do you think should be emphasized more in InnoEnergy master's programmes?	Skills & Talent	Open