AI 4
GREEN DEAL

Programme Structure and Detailed Curriculum per University

Deliverable D2.2 | August 2026

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Deliverable D2.2: “Programme Structure and Detailed Curriculum per University.”

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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+.

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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	GRENOBLE INP-UGA
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

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Glossary

Abbreviation	Definition
AESAI	Advanced Energy Systems and AI (the new programme)
AI	Artificial Intelligence
BIE	Business, Innovation & Entrepreneurship
CBL / PBL	Challenge-Based Learning / Project-Based Learning
ECTS	European Credit Transfer and Accumulation System
EFSC	Energy for Smart Cities (the existing programme being transformed)
EHEA	European Higher Education Area
EQF	European Qualifications Framework (Master = Level 7)
ESADE	ESADE Business School
ESCO	European Skills, Competences, Qualifications and Occupations
FSTP	Financial Support to Third Parties
HaDEA	European Health and Digital Executive Agency
KTH	KTH Royal Institute of Technology
ML	Machine Learning
MLO / PLO	Module / Programme Learning Outcome
UPC	Universitat Politècnica de Catalunya
VET	Vocational Education and Training
WP	Work Package

Executive Summary

The Master's in Advanced Energy Systems and AI (AESAI) is the 120 ECTS double-degree transformation of the existing Energy for Smart Cities (EFSC) Master's, developed jointly by KU Leuven, Grenoble INP-UGA and UPC BarcelonaTech, together with KTH Royal Institute of Technology as an associated partner, under the AI4GreenDeal project. The programme responds to a twin transition facing the energy sector: alongside the established engineering and business foundation of EFSC, employers increasingly need hybrid engineers who combine energy expertise with data science and AI skills. AESAI's design directly answers the four skill gaps validated in Deliverable D2.1 — broad AI literacy, digital thinking in energy systems, specialised algorithms, and big data analytics — by embedding Data & AI as a third core theme alongside Energy and Innovation & Entrepreneurship.

This deliverable presents the complete structural blueprint of the AESAI offer, fulfilling Milestone 6 of the AI4GreenDeal project ("Defined programme structure and means of delivery at each of the partner universities"). The blueprint comprises three interlocking components:

- The 120 ECTS Master's degree, structured as a common Year 1 foundation followed by a Year 2 specialisation at a second partner university. All twelve entry-to-exit combinations across the four partner universities constitute valid double-degree pathways, with each graduate receiving a diploma from both host institutions (Section 3, Appendix B).
- A catalogue of stackable online modules (~238 learning hours of content), usable both as stand-alone units for professional upskilling and as blended learning components embedded within AESAI courses (Section 6, Appendix A).
- A Business, Innovation & Entrepreneurship (BIE) journey led by ESADE Business School, delivered across both years and recognised by an ESADE certificate equivalent to 10 ECTS, giving graduates a total programme volume of 120 ECTS + 10 ECTS BIE certificate (Section 4.3).

Across the consortium, students share a common architecture: the same three core themes; Programme Learning Outcomes defined once at EQF Level 7 and applied identically across the four partner universities (Section 2.2); the same joint mandatory course *Energy and AI: Advanced*; and the same ESADE BIE journey. What differs by pathway is the Year 2 specialisation track — *Artificial Intelligence and Smart Transmission Systems* (KU Leuven), *AI for Smart*

Distribution Grids (UPC), *AI for Energy Systems in Smart Cities* (KTH), and AI for Distributed Energy Resources (Grenoble INP-UGA) — together with the specific mix of new and modified courses each partner uses to close the four skill gaps locally (Section 2.4, Section 5). Coherence across the twelve pathways is secured through shared PLOs, shared credit-progression rules, and a shared assessment philosophy (Section 7.1).

The blueprint is designed from the outset to deliver against the KPIs set in the Grant Agreement (GA): at least 150 students graduated or enrolled in the degree programme and at least 300 professional-certificate learners enrolled in the self-standing modules by M48, totalling 450 learners overall. It is also designed to be accessible: at least 30 % of female or from lower socio-economic backgrounds learners, a minimum 80 % completion rate, and up to 250 beneficiaries of financial support through the Financial Support to Third Parties (FSTP) mechanism managed under WP4. Industry co-design is embedded throughout: an Industry Advisory Board validates the curriculum, industry partners contribute real-world datasets, use cases and applied problem statements, and hosting arrangements for guest lectures, mentorships, internships, thesis projects, hackathons and venture-creation projects support the industry-collaboration KPIs set out in the GA.

The structural and delivery design set out here feeds directly into Deliverable D2.3 (Accreditation plan and agreement, Milestone 18) and Deliverable D3.1 (Programme brochures, Milestone 18) and provides the foundation on which Work Package 3 will develop the detailed course content, teaching and learning materials, and the online module catalogue ahead of the AESAI programme's first intake in the 2027 academic year.

1. Introduction

1.1 Purpose and scope of the report

This deliverable presents the programme blueprint for the Master's in Advanced Energy Systems and AI (AESAI), converting the strategy validated in Deliverable D2.1 (Skill Gap Analysis and Product Strategy) into a concrete structural and delivery design. In the terms of the Grant Agreement, D2.2 is *"An official report in English providing the blueprint for the planned MSc programme and self-*

standing modules", delivered under Work Package 2 and lead-authored by KU Leuven.

The report sets out:

- the programme vision, design principles and learning outcomes underpinning the AESAI curriculum (Section 2);
- the overall programme structure and double-degree mobility model across the four partner universities, including the twelve entry-to-exit pathways (Section 3);
- the means of delivery at each institution, covering delivery modes, active and industry co-designed learning, the ESADE Business, Innovation & Entrepreneurship journey, industry co-design and industry-collaboration KPIs, and shared assessment principles (Section 4);
- the detailed per-university curriculum for Year 1 and Year 2 at KU Leuven, KTH Royal Institute of Technology, Grenoble INP-UGA and UPC BarcelonaTech (Section 5);
- the catalogue of self-standing online modules and its stackability, recognition approach and target professional audiences (Section 6); and
- the quality, coherence and inclusion architecture that binds the twelve pathways into a single coherent programme (Section 7).

The deliverable fulfils Milestone 6 of the AI4GreenDeal project — *"Defined programme structure and means of delivery at each of the partner universities"* — and provides the foundation on which subsequent WP2 and WP3 work is built.

The blueprint set out in D2.2 is the direct input to D2.3, D3.1 and D3.3, and will be operationalised through Work Packages 3, 4, 5 and 6 ahead of the AESAI programme's first intake in the 2027 academic year.

The curriculum structures, session sequences, module content and delivery schedules set out in this document should be read as plans rather than firm commitments. They reflect the design as currently envisaged and provide a reliable basis for coordination across the consortium, but remain subject to adjustment once the programme enters the delivery phase, for reasons that may include the evolving needs and opportunities in the energy and AI sector, the pace of AI development itself, university curriculum requirements, and inter-university harmonisation constraints arising during each partner's institutional approval processes. Any material changes will be communicated to the consortium through the Project Coordination Team and, where relevant, reflected in subsequent deliverables and progress reports.

1.2 Link to D2.1 and the AI4GreenDeal evidence base

The programme structure and curriculum set out in this deliverable are anchored in InnoEnergy's *Data Science for Energy Engineers* skills framework, which provides the reference competency model for the AESAI Master's degree and its associated self-standing modules. The framework was developed by InnoEnergy through a combination of a literature review on digitalisation skill needs in the energy sector — building on prior EU-funded work, including the EDDIE Erasmus+ project and the Pact for Skills Large-Scale Partnership on the Digitalisation of the Energy Ecosystem — a review of established data science and AI competency frameworks, an analysis of vacancy notices in energy companies, and focus groups with the industry–academia Advisory Board. It is organised around a set of higher-level competencies, each further specified through detailed knowledge, skills and attitudes mapped to the European Skills, Competences, Qualifications and Occupations (ESCO) classification, and is complemented by an initial catalogue of energy use cases such as energy demand and production forecasting, smart grid security, asset optimisation and energy trading. The framework has been validated by the industry–academia Advisory Board and has already informed InnoEnergy's *Data Science for Energy Engineers* Summer School, which has trained approximately 500 participants over the past four years.

Within AESAI, this framework provides the direct methodological link between Deliverable D2.1 (*Skill Gap Analysis and Product Strategy*) and the curriculum blueprint presented here. D2.1 validated four concrete skill gaps between current energy engineering graduates and industry requirements — specialised algorithm knowledge, big data analytics, digital thinking in energy systems, and broad AI literacy (Section 2.2) — established against the *Data Science for Energy Engineers* skills framework and confirmed through consultation with the project's industrial partners as well as the Advisory Board. Every design choice in this deliverable traces directly back to closing these four gaps: the new and modified courses introduced by each partner university (Section 2.4), the joint mandatory course *Energy and AI: Advanced*, and the online modules catalogue (Section 6). The framework therefore serves a dual purpose within D2.2: guiding the curriculum design across the four partner universities to ensure a coherent 120 ECTS learning pathway, and underpinning the selection of industry partners whose data projects and use cases will continue to validate and extend the competency set in line with emerging trends in the energy transition.

1.3 Methodology

The programme structure presented in this deliverable was developed under Task 2.3 of Work Package 2 through a structured, evidence-led design process combining consortium-wide workshops, systematic curriculum mapping and industry validation. A series of working sessions across the four partner universities — KU Leuven, UPC BarcelonaTech, Grenoble INP-UGA and KTH Royal Institute of Technology — was used to reconcile institutional academic requirements with the shared AESAI target curriculum and to converge on a coherent 120 ECTS learning pathway. In parallel, the existing course catalogues of the EFSC Master's programme (documented in Deliverable D2.1, Appendix A) were systematically mapped against the target curriculum — defined jointly by the InnoEnergy *Data Science for Energy Engineers* skills framework (Section 1.2), the AESAI Programme Learning Outcomes formulated at EQF Level 7 (Section 2.2), and the EIT Overall Learning Outcomes (OLOs) for master-level graduates as reproduced in Appendix D in order to identify overlaps, gaps and opportunities for the reuse of proven course material, and to locate the additions required to close the four skill gaps identified in D2.1. The inclusion of the EIT OLOs at this stage reflects the consortium's intention to apply for the EIT Label for AESAI in due course: cross-checking the AESAI Programme Learning Outcomes against the EIT OLO framework from the outset ensures that the programme structure and course additions set out in this deliverable are compatible with EIT Label expectations, and streamlines the subsequent label application process without pre-empting any formal decision, which will be addressed as part of the accreditation and quality-assurance work reported under Deliverable D2.3.

The resulting Programme Learning Outcomes were then aligned with the European Skills, Competences, Qualifications and Occupations (ESCO) classification and calibrated against the EQF Level 7 descriptors, as set out in Section 2.2, ensuring both semantic consistency with the wider European skills landscape and formal comparability across the partner universities' national qualifications frameworks. The Industry Advisory Board and individual industry partners were consulted at key stages of this process to validate that the proposed new and modified courses genuinely address the four skill gaps identified in D2.1 — specialised algorithm knowledge, big data analytics, digital thinking in energy systems, and broad AI literacy — rather than duplicating content already covered within the existing EFSC offering.

The catalogue of stackable online modules set out in Section 6 was developed in parallel through a complementary methodology adapted to a professional-learner audience. Starting from the same four skill gaps and the *Data Science for Energy Engineers* competency framework, the consortium translated selected learning outcomes into self-standing, short-format units that can be undertaken independently or combined into structured learning pathways. Module scoping was carried out jointly by the academic partners, ESADE (for Business, Innovation & Entrepreneurship content) and NIIT (as production lead for the asynchronous online learning materials under Deliverable D3.3), with each module specified in terms of target audience, learning outcomes, indicative workload and prerequisite knowledge. A modular design principle was applied throughout, so that individual modules can feed both the professional certification pathway and, where appropriate, elective components of the degree programme. The modular structure also leaves scope for content to be revisited over time in light of the evolution of AI technologies and digital tools, subject to the programme's financial sustainability model and the resources available under WP6 (Deliverable D6.3). Industry partners were consulted to confirm the practical relevance of the proposed modules for working professionals and to identify use cases and datasets that may underpin the applied learning activities.

2. Programme Vision and Design Principles

2.1 From EFSC to AESAI: rationale

The Energy for Smart Cities (EFSC) programme was originally designed for students interested in the energy transition from both engineering and business perspectives. Its curriculum accordingly combines a strong energy engineering foundation with courses in energy economics and regulation, and a structured Innovation & Entrepreneurship journey. This configuration has served the programme's target profile well and remains the starting point on which the new Master's in Advanced Energy Systems and AI (AESAI) builds.

The rapid advance of artificial intelligence has, however, substantially reshaped industry expectations of energy engineering graduates. Companies across the energy sector now face a twin transition in which decarbonisation and digitalisation are tightly coupled, and increasingly seek hybrid engineers able to address energy problems using state-of-the-art AI and data science techniques.

This shift was documented and validated in Deliverable D2.1 (*Skill Gap Analysis and Product Strategy*), which identified four concrete skill gaps between current energy engineering graduates and industry requirements: broad AI literacy, digital thinking in energy systems, specialised algorithm knowledge, and big data analytics. The AESAI programme has been designed specifically to close these gaps, evolving the EFSC foundation into a curriculum that equips a new generation of energy engineers with the combined domain, digital and entrepreneurial competencies required by the rapidly changing energy sector.

2.2 Graduate profile and Programme Learning Outcomes

To formalise the graduate profile, the Programme Learning Outcomes of the AESAI Master's are formulated in line with the descriptors of Level 7 of the European Qualifications Framework (EQF) (Council Recommendation 2017/C 189/03), which distinguish between knowledge, skills, and responsibility and autonomy. The outcomes are organised around the programme's three core themes: Energy, Innovation & Entrepreneurship, and Data & AI. The knowledge and skills terminology is drawn from the European Skills, Competences, Qualifications and Occupations (ESCO) classification. Since Data & AI is the core theme that is new relative to the existing EFSC curriculum, Tables 1 and 2 additionally indicate which of the four skill gaps identified in Deliverable D2.1 are addressed by each Data & AI outcome.

Knowledge

At EQF Level 7, knowledge is advanced and involves a critical understanding of theories and principles at the forefront of a field of work or study. A graduate of AESAI is expected to hold advanced knowledge across all three core themes of the programme, as summarised in Table 1 below. The first two columns list the Programme Learning Outcomes, grouped by core theme; the third column provides a description of the specific knowledge term; and the fourth column identifies the skill gaps addressed by the new learning outcomes. As energy and innovation knowledge were already present in the EFSC curriculum, the corresponding outcomes do not address any new skill gap and are marked *N/A* (not applicable).

On the energy side, graduates should hold in-depth knowledge of the electrical, thermo-mechanical and economic aspects of power systems. The programme also has a strong business component, which provides students with knowledge of innovation, entrepreneurship and typical business models in the energy sector. Finally, the new Data & AI theme covers a broad range of digital knowledge that can be mapped to the skill gaps identified in D2.1. Graduates should be equipped with knowledge of emerging AI developments, the foundational principles of AI, big data processing, and at least one general-purpose programming language.

Core theme	ESCO Knowledge	Description	Addressed skill gap
Energy	Power engineering	Theoretical and factual knowledge of electrical power generation, transmission, distribution and control that underpins the analysis and design of power systems.	N/A
	Mechanical engineering	Theoretical and factual knowledge of thermo-mechanical systems such as thermal systems, turbines, drives, and engines.	N/A
	Energy market	Knowledge of the structure, regulation, and price formation of European electricity markets.	N/A
Business, Innovation & Entrepreneurship	Innovation processes	Knowledge of the stages and methods through which new ideas are developed into viable solutions.	N/A
	Entrepreneurship	Knowledge of the venture-creation process, from idea generation to business launch.	N/A
	Business model	Knowledge of how a venture's value proposition, resources and revenue streams fit together.	N/A
Data & AI	Emergent technologies	Awareness of recent trends and innovations in AI and other digital technologies, needed to keep pace with the fast-evolving generative AI tools embedded across the programme.	**Broad AI literacy**
	Principles of artificial intelligence	Understanding the foundational concepts and paradigms of AI and machine learning.	**Specialised algorithm knowledge**
	Data mining	Knowledge of the methods used to extract patterns and insights from large, heterogeneous energy datasets.	**Big data analytics**

	Python (computer programming)	Knowledge of a general-purpose programming language used throughout the curriculum to translate energy problems into computational, data-driven solutions.	**Digital thinking in energy systems**

Table 1: Programme-level learning outcomes: Knowledge (EQF Level 7).

Skills

At EQF Level 7, skills are specialised problem-solving skills required in research or innovation, in order to develop new knowledge and procedures and to integrate knowledge from different fields. A graduate of AESAI is expected to master the practical and cognitive skills summarised in Table 2 below.

Within the Energy theme, students should acquire a broad set of energy-related skills, particularly around central topics such as electric power systems, thermo-mechanical systems, and energy policy and economics. Within the Business, Innovation & Entrepreneurship theme, graduates need to develop a solid set of transversal skills, including teamwork, communication, critical thinking and adaptability. These are complemented by broad business acumen that can be applied to analyse a range of business scenarios in the energy sector. Within the Data & AI theme, the four skill gaps identified in Deliverable D2.1 are addressed through four corresponding skills: familiarity with the implementation of machine learning algorithms, the ability to process and visualise large volumes of data, the ability to address complex energy problems through programming tools, and an informed awareness of emerging digital developments, in particular in the field of artificial intelligence.

Core theme	ESCO Skill	Description	Addressed skill gap
Energy	Design electric power systems	Ability to understand and design generation, transmission and distribution infrastructure.	N/A
	Design electromechanical systems	Ability to design thermo-mechanical and electromechanical components and systems.	N/A
	Develop energy policy	Ability to formulate and evaluate policy options that support the energy transition.	N/A

Business, Innovation & Entrepreneurship	Work as a team	Ability to collaborate effectively in multidisciplinary settings, with critical thinking and a flexible mindset.	N/A
	Apply business acumen	Ability to read business situations and make sound commercial judgements, and the development of business intuition.	N/A
Data & AI	Utilise machine learning	Ability to apply machine learning and optimisation algorithms (e.g., forecasting, reinforcement learning) to energy system problems.	**Specialised algorithm knowledge**
	Perform data analysis	Ability to extract meaningful insights and trends from operational, market, and environmental energy data.	**Big data analytics**
	Use scripting programming	Ability to translate energy engineering problems into computational, programming-based solutions.	**Digital thinking in energy systems**
	Have computer literacy	Ability to confidently use computers, software and digital tools as the general foundation for engaging with AI-driven methods, and the ability to keep up with technology changes.	**Broad AI literacy**

Table 2: Programme-level learning outcomes: Skills (EQF Level 7).

Responsibility and Autonomy

At EQF Level 7, graduates are expected to manage and transform complex, unpredictable and multidisciplinary contexts that require new strategic approaches, and to take responsibility for contributing to professional knowledge and practice. Within AESAI, this means that graduates can independently combine advanced energy, digital and business competencies to address real-world sustainability challenges. Throughout the programme, students develop this dimension through the Master's Thesis (typically industry-linked), consulting projects with partners from the InnoEnergy ecosystem, and the venture-building activities undertaken during the ESADE Business, Innovation & Entrepreneurship journey (Section 4.3).

More concretely, graduates should be able to address complex energy problems involving multiple stakeholders on the basis of their own analytical approach. In doing so, they need to communicate their strategy and findings clearly, in order to support informed decision-making. Graduates should be able to explain sophisticated data-driven analyses to both expert and non-expert audiences, and to justify the choices and recommendations they put forward. They exercise autonomy in contexts where energy, market, regulatory and technological conditions are still evolving, adjusting their approach accordingly while remaining accountable for the quality, safety and ethical implications of their decisions.

Reflecting the Data & AI theme in particular, graduates take ownership of the responsible and critical use of AI tools. They recognise the limitations, biases and data protection implications of AI-based methods. In addition, graduates take the initiative to continue developing their digital competencies beyond graduation, in step with the rapid pace of innovation in artificial intelligence and the wider energy transition.

2.3 Design pillars

Beyond the course content itself, the design of the AESAI programme actively contributes to its innovative ambitions. Deliverable D2.1 established four design pillars that shape the curriculum architecture set out in this deliverable:

- **Embedded digital tools.** AI and data science methods are integrated into energy courses to the greatest extent possible, so that students develop digital competencies through hands-on application to energy problems rather than in isolation from their domain of study.
- **Tiered competency development.** All students build a common foundation of AI literacy in Year 1, ensuring baseline digital fluency across the cohort. Students wishing to specialise further can then engage more deeply with advanced AI and digital topics through dedicated elective courses and specialised modules in Year 2.
- **Applied, practice-oriented learning.** Through the industry partners of the AI4GreenDeal consortium, the programme has access to real-world energy datasets, use cases and applied problem statements, providing a strong basis for project-based and challenge-based learning, thesis work and industry-linked capstone activities (Section 4.2, Section 4.4).
- **Soft-skill and leadership development.** The ESADE-led Innovation & Entrepreneurship journey is embedded within the technical curriculum across both years (Section 4.3), giving students structured opportunities

to develop leadership, communication, teamwork, negotiation and venture-building skills alongside their technical training.

2.4 Alignment with the identified skill gaps

To achieve the Programme Learning Outcomes set out in Section 2.2, a range of new and modified courses, together with a catalogue of stackable online modules, will be introduced into the AESAI curriculum. The following subsections describe the additions proposed by each partner university and explain how they contribute to addressing the four skill gaps identified in Deliverable D2.1 — broad AI literacy, digital thinking in energy systems, specialised algorithm knowledge, and big data analytics.

Courses

Table 3 lists all newly introduced and modified courses under the AI4GreenDeal project, grouped by the partner university delivering them. The final column identifies the skill gaps addressed by each course. The purpose of this overview is to illustrate how the AESAI additions across the four partner universities collectively address the four skill gaps identified in Deliverable D2.1. The full per-university curriculum is set out in Section 5.

A central consideration during the development of the AESAI programme was ensuring the alignment of the programme vision across the four partner universities. Through dedicated collaborative work, the partners have agreed on four common principles that safeguard curriculum harmonisation while respecting the constraints of each institution's national and internal regulations.

First, each partner anchors at least one mandatory digital course in Year 1 of its programme, laying the foundation for more advanced content in Year 2. In Year 2, each partner offers more specialised data science and AI courses, allowing students to develop their digital competencies in line with the thematic focus of the host university's specialisation track.

Second, each partner incorporates the joint course *Energy and AI: Advanced* into its curriculum as a mandatory element. The course is delivered jointly across the consortium, with each partner university contributing one quarter of the course content. All AESAI students take the course in the first semester of Year 2. In practice, this means that students attend one quarter of the lectures in person at their host university and follow the remaining three quarters synchronously in a hybrid format from the other three partner universities. The course covers advanced topics at the intersection of the energy and AI domains and is a central component of the AESAI Master's. The accreditation of this course differs per university, and therefore the number of credits of this course is further detailed in Section 5.

Third, each partner has made a comparable effort in introducing new courses in terms of ECTS. Under the current design, the new course content ranges between 22 and 39 ECTS across universities, comprising a combination of mandatory and elective courses.

Fourth, each partner addresses all four skill gaps through its proposed additions. As university courses typically span a broad range of content, most courses contribute to more than one skill gap; the most prominent skill gaps are indicated in the rightmost column of Table 3. In Year 1, the new mandatory courses tend to address more foundational skill gaps such as broad AI literacy and data processing, while the more advanced courses in Year 2 focus on specialised algorithms and applied digital thinking in energy systems.

University	Course	Year	ECTS	Type	Addressed skill gap(s)
KU Leuven	Energy and AI: Foundations	1	3	Mandatory	Digital thinking in energy systems Broad AI fluency
	Smart Distribution Systems	1	3	Mandatory	Specialised algorithms Big data analytics
	Artificial Neural Networks and Deep Learning	1	4	Elective	Specialised algorithms
	Optimisation	1	6	Elective	Specialised algorithms
	Optimisation Problems in Energy Systems	2	3	Mandatory	Specialised algorithms Digital thinking in energy systems
KTH	AI Applications in Sustainable Energy Engineering	1	6	Mandatory	Digital thinking in energy systems Big data analytics
	Machine Learning, Advanced Course	1	7.5	Elective	Specialised algorithms
	Electricity Pricing and Emissions	1	6	Elective	Digital thinking in energy systems Big data analytics

	Cybersecurity Overview	2	7.5	Elective	Digital thinking in energy systems Broad AI fluency
	Computer Applications and Machine Learning in Electric Power Systems	2	7.5	Elective	Specialised algorithms Digital thinking in energy systems
Grenoble INP-UGA	Computer Sciences	1	5	Mandatory	Big data analytics Broad AI fluency
	Data Science Fundamentals	1	5	Mandatory	Big data analytics Broad AI fluency
	Modelling and Dispatch of Smart Power	1	5	Mandatory	Digital thinking in energy systems Specialised algorithms
	Electrical Grids and Decentralisation Management	1	3	Elective	Digital thinking in energy systems Specialised algorithms
	Smart Energy Solutions - Energy for Buildings and Territories	1	5	Mandatory	Digital thinking in energy systems Specialised algorithms Broad AI fluency
	Intelligent Distributed Energy Resources	2	5	Mandatory	Digital thinking in energy systems Specialised algorithms
	Digital Twins for Energy Systems	2	3	Mandatory	Digital thinking in energy systems Specialised algorithms
	Smart Energy Systems	2	5	Mandatory	Digital thinking in energy systems Specialised algorithms
UPC Barcelona	Renewable Energy Projects	1	5	Mandatory	Digital thinking in energy systems Big data analytics
	Forecasting for Power Systems	2	5	Mandatory	Specialised algorithms
	Artificial Intelligence in Energy Systems	2	5	Mandatory	Specialised algorithms

	Control and Automation for the Efficient Use of Energy	2	5	Elective	Digital thinking in energy systems Broad AI fluency
	Smart Grids	2	5	Elective	Digital thinking in energy systems
	Data-Driven Challenges for Energy Engineering	2	5	Elective	Digital thinking in energy systems Big data analytics
All universities	Energy and AI: Advanced	2	See Sec. 5	Mandatory	Digital thinking in energy systems Specialised algorithms

Table 3: New and added AESAI courses mapped to the skill gaps identified in D2.1, by university.

Online Stackable Modules

In addition to the courses delivered locally by each partner university, the AESAI programme includes a catalogue of stackable online modules co-developed by the consortium and shared across the whole cohort. These modules are a core component of the AI4GreenDeal offer rather than an add-on: under the Grant Agreement, the consortium is committed to designing and delivering approximately 238 hours of self-standing online learning content, complementing the 120 ECTS double-degree Master's programme and extending the project's reach to a wider audience of learners.

The modules are designed to serve three interrelated purposes. First, as flexible lifelong learning opportunities for working professionals in the energy sector, they allow individuals to build specific data science and AI competencies without committing to a full degree programme, and to combine short units into structured learning pathways leading to professional certification. Second, as self-standing units, they enable learners from diverse backgrounds — including graduates, mid-career professionals and career-changers — to access targeted content in areas such as AI literacy, responsible generative AI use, and applied data science for energy systems. Third, where appropriate, individual modules can be embedded within the AESAI Master's programme as complementary learning resources or elective components, ensuring coherence between the degree pathway and the wider certification offer. Together, these functions support the project's commitment to broaden access to advanced digital skills for the European energy transition and to reach the learner targets set out in the Grant Agreement.

Across the catalogue, the modules are developed in close collaboration with the project's industry partners, who contribute real-world datasets, use cases, applied problem statements and subject-matter expertise. This ensures that the content reflects current industrial practice, exposes learners to authentic energy-sector challenges, and reinforces the direct link between the AESAI curriculum and the evolving needs of the energy industry.

Table 4 below lists the planned modules, indicating the lead consortium partner and the skill gap(s) addressed by each module.

#	Module	Lead partner(s)	Learning Hours	ECTS	Skill gap (D2.1)
1	AI for Innovation and Entrepreneurship	ESADE	30	1	Broad AI literacy
2	Responsible Use of AI	InnoEnergy	25–30	1	Broad AI literacy
3	Joint introductory course on energy, data science and AI	KU Leuven, Grenoble INP-UGA, UPC Barcelona	30	1	Specialised algorithms Broad AI literacy
4	Specialised module – KU Leuven (flexibility, value-oriented & hierarchical forecasting, causal ML, physics-informed NNs)	KU Leuven	30	1	Specialised algorithms Digital thinking in energy systems
5	Specialised module – UPC (data-centre demand response, physics-informed NNs, diffusion models, grid reinforcement, topology identification)	UPC Barcelona	30	1	Specialised algorithms Big data analytics
6	Specialised module – Grenoble INP-UGA (ML for Smart Grid/City, Big Data, SCADA, home automation & energy management)	Grenoble INP-UGA	30	1	Big data analytics Digital thinking in energy systems
7	The past, present and future of energy systems in Belgium, Spain and France	KU Leuven, UPC Barcelona, Grenoble INP-UGA	25–30	1	Digital thinking in energy systems

8	AI and the Green Deal: Industrial Perspective	ESADE	20	1	Digital thinking in energy systems Broad AI literacy
9	AI and the Green Deal: Startup Case	ESADE	10	1	Broad AI literacy Digital thinking in energy systems

Table 4: Overview of the developed online modules, lead consortium partners, and skill gaps (D2.1) addressed

By design, the online modules are compact units of learning content, each corresponding to no more than 1 ECTS. This lean format allows individual modules to be revisited over time as the underlying technologies evolve, which is particularly relevant for topics addressing broad AI literacy. Two modules illustrate this dimension of the catalogue. *AI for Innovation and Entrepreneurship* (ESADE) equips learners with an operator's mindset for building with AI without code — from context engineering and agentic tools to AI-native business models — and culminates in a governed capstone build undertaken within the guardrails of the EU AI Act. *Responsible Use of AI* (InnoEnergy) is a compact module preparing learners to use generative AI effectively, critically and with integrity, covering advanced prompting, the red-teaming of AI outputs, academic and professional disclosure practices, the human dimension of AI collaboration, and the sustainability footprint of AI infrastructure — an area of direct relevance to future energy professionals.

The compact format also allows the partner universities to showcase their specialised research in an accessible way. Three modules address state-of-the-art topics in specialised algorithms and digital thinking in energy systems. The KU Leuven specialised module covers energy flexibility archetypes, value-oriented and hierarchical forecasting, causal machine learning for energy modelling, and physics-informed neural networks. The UPC BarcelonaTech specialised module addresses optimisation for data-centre demand response, physics-informed augmented Lagrangian neural networks, conditional diffusion modelling, data-driven grid reinforcement under uncertainty, and topology identification in low-voltage distribution grids. The Grenoble INP-UGA specialised module focuses on machine learning and big data in the smart grid and smart city context, SCADA architectures, and home automation and energy management for smart housing.

To provide the foundations underpinning these advanced research modules, a joint introductory course on energy, data science and AI is co-taught by KU

Leuven, Grenoble INP-UGA and UPC BarcelonaTech. The module introduces core data science, AI and machine learning algorithms — supervised and unsupervised learning, forecasting, and transfer and federated learning — alongside optimisation and optimal decision-making, illustrated through practical energy use cases.

Finally, two modules take a wider perspective on the intersection of the energy and AI domains. *The past, present and future of energy systems in Belgium, Spain and France*, co-taught by KU Leuven, UPC BarcelonaTech and Grenoble INP-UGA, examines how the three national systems have evolved and the role that data and AI have played, and will continue to play, in that evolution. *AI and the Green Deal: Industrial Perspective* (ESADE) explores real industry applications of AI across smart grids, demand forecasting, predictive maintenance, emissions monitoring and regulatory compliance, while the companion module *AI and the Green Deal: Startup Case* (ESADE) examines the cleantech start-up ecosystem through cases in energy storage, green hydrogen, energy efficiency, sustainable mobility and smart grids.

3. Advanced Energy Systems and AI Master Programme Structure

3.1 Overall architecture

The Master's in Advanced Energy Systems and AI (AESAI) is a two-year, 120 ECTS double-degree programme delivered jointly by KU Leuven, UPC BarcelonaTech and Grenoble INP-UGA, together with KTH Royal Institute of Technology as an associated partner, within the InnoEnergy Masters+ framework. Its architecture follows a *"common Year 1 / specialised Year 2"* model: students complete a 60 ECTS foundation year at one of the four partner universities and then move to a second partner university for a 60 ECTS specialisation year, receiving a diploma from each institution upon successful completion.

Year 1 — Common foundation

The first year provides a shared foundation across all four partner universities in energy engineering, energy markets and economics, and introductory AI, data science and computational methods for energy applications. This ensures that, regardless of entry university, every student develops a consistent baseline of technical, systems and digital competencies before progressing to specialisation. The design of Year 1 is directly informed by the skill gaps validated in Deliverable D2.1, with particular emphasis on establishing broad AI literacy and digital thinking in energy systems from the outset of the programme.

Year 2 — Advanced specialisation

In the second year, students undertake advanced specialisation at their host university, structured around each institution's thematic strengths at the intersection of energy systems and AI:

- **KU Leuven** — *Artificial Intelligence and Smart Transmission Systems*
- **UPC BarcelonaTech** — *AI for Smart Distribution Grids*
- **KTH Royal Institute of Technology** — *AI for Energy Systems in Smart Cities*
- **Grenoble INP-UGA** — *AI for Distributed Energy Resources*

Each specialisation track combines advanced taught courses with applied and project-based learning, and culminates in a 30 ECTS Master's Thesis carried out at the host university, typically in collaboration with an industry or research partner from the AI4GreenDeal consortium.

Within each Year 2 specialisation, students engage with at least two AI-in-energy application-orientation modules drawn from the taught curriculum of the host partner university, in line with the programme design set out in the Grant Agreement. These modules deepen the learner's exposure to applied AI use cases in specific energy domains — for example smart transmission systems at KU Leuven, smart distribution grids at UPC BarcelonaTech, energy systems in smart cities at KTH, and digital intelligence for future energy systems at Grenoble INP-UGA — and are complemented by the joint mandatory course *Energy and AI: Advanced*, which brings the whole cohort together across all four thematic strengths (Section 3.2). The specific application-orientation modules available at each partner university are listed in the per-university curricula in Section 5, and their mapping to the four skill gaps identified in D2.1 is set out in Section 2.4.

Business, Innovation & Entrepreneurship journey

Across both years, students follow the ESADE-led Business, Innovation & Entrepreneurship (BIE) journey (Section 4.3), which develops the entrepreneurial mindset, venture-building capabilities and sustainability competencies required to translate technical expertise into real-world impact. Upon successful completion, students receive a dedicated BIE certificate from ESADE Business School, representing a learning volume equivalent to 10 ECTS, which complements the disciplinary diplomas awarded by the two host partner universities. In aggregate, this brings the total learning volume of the AESAI offer to 120 ECTS + a 10 ECTS-equivalent BIE certificate, in line with the Grant Agreement.

Wider InnoEnergy ecosystem

Beyond the taught curriculum, AESAI students benefit from the wider ecosystem of services, communities and activities offered by InnoEnergy across its Masters+ portfolio. This includes access to InnoEnergy's flagship industry and innovation events — such as *The Business Booster* (TBB), *ENLIT Europe* and the *InnoEnergy Connect* community events — as well as engagement with InnoEnergy's ecosystem of supported start-ups and scale-ups, the *InnoEnergy Skills Institute*, and the Masters+ alumni network. Together, these opportunities give students direct exposure to industry leaders, emerging technologies and entrepreneurial pathways, positioning them within a Europe-wide community of practitioners working on the twin energy and digital transition.

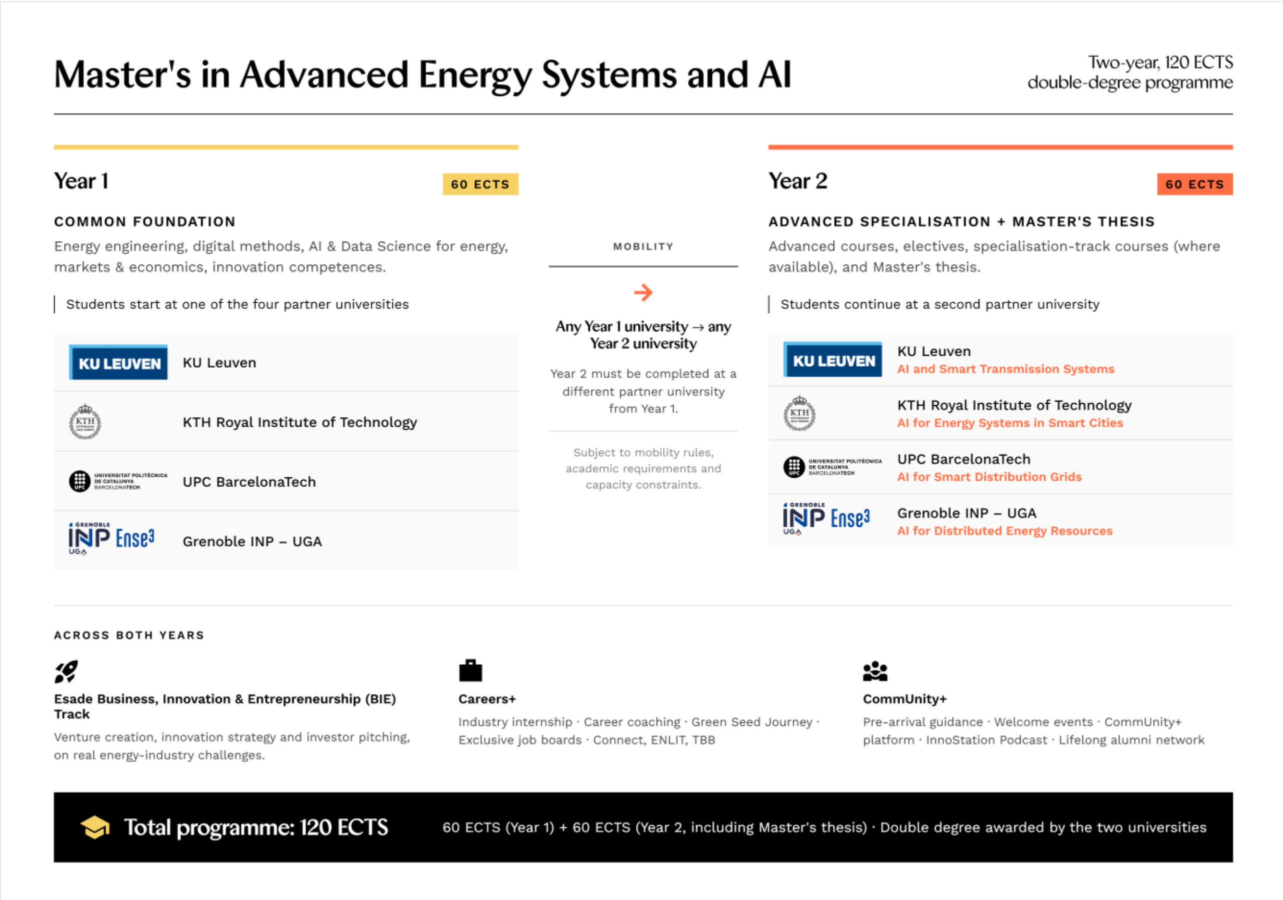

Figure 1: AESAI double-degree architecture — Year 1 common foundation and Year 2 specialisation tracks across the four partner universities

3.2 Double-degree mobility model and pathways

Advanced Energy Systems and AI is delivered as a two-year, two-university mobility programme. Students enter at one of the four partner universities for their Year 1 foundation (entry university) and move to a different partner university for their Year 2 specialisation (exit university), receiving a diploma from each institution upon successful completion. All twelve entry-to-exit combinations across the four partner universities are valid pathways, giving students significant flexibility to design a programme that matches their academic interests, career ambitions and preferred European country.

Both the Year 1 entry university and the Year 2 specialisation university are selected by the applicant at the point of application. Candidates are asked to indicate their preferred entry–exit combination as part of the standard admission process, and successful applicants are formally allocated to a full pathway (Year 1 host + Year 2 host) at the point of admission. This front-loaded design allows students, partner universities and the InnoEnergy Programme Coordination team to plan mobility, visa arrangements and academic capacity well in advance of the start of the programme.

To ensure that applicants understand what each pathway entails before committing to a choice, prospective students receive detailed information on the mobility framework, partner university specialisations, mandatory ECTS thresholds, national regulatory requirements, and application procedures through a range of channels during the recruitment cycle. These include the AI4GreenDeal and InnoEnergy Masters+ websites, dedicated recruitment webinars, social media campaigns, and one-to-one exchanges with the Programme Coordination team on request. The intention is that every applicant makes their Year 1 and Year 2 selection on the basis of full and consistent information about the academic content, mobility requirements and progression rules associated with each pathway.

At the start of Year 1, the Programme Director and Programme Coordinator organise a dedicated welcome event for the incoming cohort. The event covers all key elements of the programme, including the double-degree structure, the Year 1 to Year 2 mobility framework, the mandatory ECTS thresholds for progression, the specific national regulatory requirements of each partner university (in particular the French national rules relevant to Grenoble INP-UGA, described below), academic support arrangements, and the Innovation & Entrepreneurship journey. This ensures that students are fully briefed on their obligations and available support from the outset of the programme, reinforcing the information already provided during recruitment.

Once admitted, a student may request a change to their originally selected Year 2 university under exceptional circumstances. Such requests must be submitted in writing to the Programme Coordinator, together with a clear justification (for example, documented academic, personal, medical or force-majeure reasons). Each request is then reviewed and decided by the Programme Steering Committee, in consultation with the two partner universities concerned. Approval is subject to: (i) available capacity at the newly requested Year 2 host university; (ii) the academic entry requirements of that host university being met; and (iii) any administrative or visa-related constraints associated with the change. Where a change is approved, the student is formally reallocated and receives updated mobility documentation. The guiding principle throughout is to accommodate legitimate individual needs while maintaining fairness across the cohort and predictability for partner-university academic planning.

Movement from Year 1 to Year 2 is governed by two complementary progression rules:

- **Programme-wide baseline:** Students are required to have earned a minimum of 48 ECTS from Year 1 (equivalent to 80% of Year 1 coursework) and to have settled all Year 1 tuition fees before enrolling in Year 2.
- **Grenoble INP-UGA exception:** Where Grenoble INP-UGA is the Year 2 destination, French national regulations require students to have completed the full 60 Year 1 credits before enrolling in Year 2. This national requirement overrides the 48 ECTS programme baseline for this specific pathway. Individual exceptions may be considered on a case-by-case basis by Grenoble INP-UGA admissions, in line with its institutional regulations.

These progression rules are communicated to students during recruitment, confirmed in the admission documentation, and reiterated at the Year 1 welcome event, so that any risk of falling below the required credit thresholds can be identified and addressed early, in dialogue with the local academic coordinator.

Entry (Y1) → Exit (Y2)	Credit-progression note	Language note
KU Leuven → KTH	Standard 48 ECTS floor	English only
KU Leuven → UPC	Standard 48 ECTS floor	English only
KU Leuven → GINP	Full 60 ECTS required at GINP	GINP French course recognised by KUL – no extra step
KTH → KU Leuven	Standard 48 ECTS floor	English only
KTH → UPC	Standard 48 ECTS floor	English only
KTH → GINP	Full 60 ECTS required at GINP	GINP French course recognised by KTH – no extra step
UPC → KU Leuven	Standard 48 ECTS floor	English only
UPC → KTH	Standard 48 ECTS floor	English only
UPC → GINP	Full 60 ECTS required at GINP	French swapped for 2 ECTS Integrative Project (capacity-limited)
GINP → KU Leuven	Standard 48 ECTS floor (GINP Y1 already met the stricter 60)	Y1 French course recognised by KUL

GINP → KTH	Standard 48 ECTS floor	Y1 French course recognised by KTH
GINP → UPC	Standard 48 ECTS floor	Y1 French course swapped for Integrative Project (capacity-limited)

Table 5: Entry (Y1) → Exit (Y2) pathway matrix: credit-progression and language requirements.

Language of instruction along the pathway

The language of instruction is likewise pathway-dependent. The AESAI programme is delivered in English throughout; however, the host Master's at Grenoble INP-UGA includes a fixed 2 ECTS mandatory course *French Language, Culture and Employability*, reflecting the requirements of the French national qualification. KU Leuven and KTH Royal Institute of Technology recognise this course as-is on pathways ending at Grenoble INP-UGA. UPC BarcelonaTech does not recognise credits awarded for French language study; on UPC↔Grenoble INP-UGA pathways, students therefore complete a 2 ECTS *Integrative Project* at Grenoble INP-UGA in place of the French language course. This arrangement is a capacity-limited administrative workaround, viable at low student volumes and reviewed cycle by cycle, rather than a general exemption from the French language requirement.

EIT Label

Students who additionally meet the specific requirements of the EIT Label may, on successful completion of the programme, receive an EIT Label Certificate issued by ISE Foundation, alongside the two disciplinary diplomas awarded by their entry and exit universities.

3.3 Curriculum map and outcomes-alignment matrix

The full course-by-semester curriculum for all four partner universities is set out in Section 5 of this report, with each course classified by ECTS value, mandatory/elective status, and the Energy / Energy–AI / Data & AI / General component split used in Table 3. Programme Learning Outcomes are defined at EQF Level 7 in Section 2.2 and mapped to the ESCO descriptors for knowledge, skills, and responsibility and autonomy, and linked to the four skill gaps identified in Section 2.4. The mapping of courses against those Programme Learning Outcomes and the four skill gaps is also set out in Section 2.4, in Table 3 for the courses and Table 4 for the online stackable modules.

3.4 Admission requirements and target intake

Admission to the AESAI Master's is designed to attract high-potential candidates from engineering and closely related STEM backgrounds who are motivated to work at the intersection of energy systems and AI. Applicants are expected to hold a Bachelor's degree of 180–240 ECTS in engineering or a cognate STEM discipline, and to demonstrate a solid foundation in mathematics (equivalent to at least 30 ECTS), programming (typically Python, MATLAB or C/C++) and core energy engineering concepts. Prior exposure to data analysis or machine learning is welcomed but not required, as the programme is explicitly designed to build data science and AI competencies on top of an engineering foundation. Where an applicant meets the overall academic profile but lacks specific prerequisites, conditional admission may be offered, subject to the successful completion of bridging modules prior to or during the first semester. A curated set of bridging and harmonisation resources — combining InnoEnergy online courses and selected external open courses — is provided in Appendix E to support conditionally admitted applicants and any student wishing to refresh specific prerequisites during the programme.

Language of instruction

The programme is delivered entirely in English. English-language proficiency must be evidenced through an IELTS Academic score of ≥ 6.5 (with no individual section below 5.5), a TOEFL iBT score of ≥ 92 (with a writing sub-score of ≥ 22), or a Cambridge CAE/CPE grade A–C. This requirement is waived for applicants whose previous degree was taught in English at institutions or in countries recognised by the partner universities. The full set of admission requirements — including partner-university-specific prerequisites, documentary evidence required at application, and the treatment of non-EU qualifications — is provided in Appendix C to this deliverable.

Point of admission and pathway selection

As set out in Section 3.2, both the Year 1 entry university and the Year 2 specialisation university are selected by the applicant at the point of application. Candidates are asked to indicate their preferred entry-to-exit combination as part of the standard admissions process, and successful applicants are formally admitted to a full pathway (Year 1 host university and Year 2 host university) at the point of admission. This design allows students, partner universities and the InnoEnergy Programme Coordination team to plan mobility, visa arrangements and academic capacity well in advance of the start of the programme, and provides applicants with predictability about the full two-year experience they are joining.

Target intake

AI4GreenDeal targets a minimum of 150 students graduated or enrolled in the AESAI degree programme by M48. The exact per-cohort intake target for each academic year will be set by the Programme Steering Committee, taking into account partner-university capacity, industry demand signals, and recruitment performance across successive intake cycles. Progress against the 150-student KPI will be monitored under the AI4GreenDeal governance framework (Deliverable D1.2) and reported through the standard project reporting cycle.

Accessibility and inclusion

The admission model is designed to be accessible to a broad base of applicants and to support the project's inclusion targets. The Grant Agreement commits AI4GreenDeal to reaching a minimum of 30 % female learners or learners from lower socio-economic backgrounds across its degree and self-standing module offerings by M48, and to supporting up to 250 beneficiaries of financial or other support through the Financial Support to Third Parties (FSTP) mechanism managed under Work Package 4. Conditional admission with bridging support (above), delivery entirely in English, and the availability of FSTP-funded scholarships, fee waivers and mobility budgets for eligible applicants together ensure that AESAI is reachable by candidates from a wider range of academic, geographic and socio-economic starting points. FSTP eligibility criteria and selection processes are defined under Task 4.0 of the AI4GreenDeal work plan and reported through Deliverable D4.1 (*Intermediary and Final List of Graduated and Certified Students*).

Financial Support to Third Parties (FSTP)

Accessibility to the AESAI degree programme is operationalised for eligible learners through the FSTP mechanism established under the AI4GreenDeal work plan. Under Task 4.0 of Work Package 4, a dedicated envelope of up to €2 million is set aside to fund scholarships, fee waivers and mobility budgets, with the aim of supporting up to 250 beneficiaries across the degree programme and the self-standing modules combined. In line with Digital Europe Programme (DEP) rules, FSTP support is available only to applicants who hold the nationality of an EU Member State or of another Digital Europe Programme eligible country (or, where applicable, meet the residency criteria published in the FSTP call). Detailed FSTP allocation criteria, selection processes and beneficiary reporting are managed under Work Package 4 and reported through Deliverable D4.1.

4. Means of Delivery

4.1 Delivery modes

The AESAI programme is designed to be delivered through a combination of in-person, hybrid, online and — where applicable — immersive learning experiences, in line with the delivery ambitions set out in the Grant Agreement and in Work Package 3. The choice of delivery mode for each component is driven by pedagogical purpose rather than by convenience: components that benefit from face-to-face interaction, laboratory work or physical infrastructure are delivered on campus, while components that lend themselves to asynchronous engagement, cross-university teaching or professional-learner access are delivered online or in a hybrid format. Across all modes, quality assurance is carried out under each partner university's national framework, and shared design conventions across the consortium safeguard the consistency and comparability of the learner experience across the twelve possible double-degree pathways.

In-person delivery at partner universities

The majority of the taught curriculum in Year 1 and in the Year 2 specialisation tracks (Section 5) is delivered in person at the host partner university. This includes core lectures, exercise sessions, laboratory work and applied project work that draws on each institution's research infrastructure, teaching staff and industry ecosystem. In-person delivery also supports the cohort-building and networking dimensions of the AESAI experience, both within each host university and — through the ESADE Innovation & Entrepreneurship journey (Section 4.3) — across the whole cohort at shared residential moments in Barcelona and Stockholm.

Hybrid delivery for shared and cross-university components

Selected components of the AESAI programme are delivered in hybrid mode, combining synchronous in-person teaching at one partner university with synchronous remote participation from students at the other partner universities. The most visible example is the joint mandatory course *Energy and AI: Advanced*, which is jointly taught by all four partner universities in Year 2 (Section 3.1). Each partner delivers one quarter of the course content, with students physically attending the segment offered by their host university and following the other three segments synchronously in a digital format. This hybrid arrangement operationalises the *"cooperative teaching formats"* foreseen in Task 2.2 of the Grant Agreement and gives every AESAI student direct exposure to the specialisation strengths of all four partner universities within a single course. Hybrid delivery is enabled by shared platforms and equipment set-up coordinated under Work Package 3 (Task 3.2), including cloud computing infrastructure for teacher and student data analysis and the appropriate hardware for hybrid rooms at each partner site.

Online and blended delivery

The online modules catalogue (Section 6) is delivered fully asynchronously online, allowing self-paced professional learners to engage flexibly and enabling the same content to be embedded, in blended mode, within taught AESAI courses. Under Work Package 3 (Tasks 3.1–3.4), the consortium is developing approximately 238 hours of high-quality interactive online content — combining short videos, interactive pages, infographics, exercises, quizzes and applied assignments — designed for dual use as both stand-alone modules for professional upskilling and blended components within AESAI courses (Section 6.1). A shared learning platform, curated under Task 3.2 and provided with instructional-design support by NIIT, underpins this delivery. Blended delivery within taught courses may include flipped-classroom formats, in which online modules are studied in advance of live sessions, and elective units in which online modules substitute for or complement traditional lecture content.

Immersive learning experiences (XR)

Alongside the delivery modes above, the AESAI blueprint anticipates the integration of immersive learning experiences based on extended reality (XR) — including virtual and augmented reality — in selected courses. As foreseen in the Grant Agreement, an XR learning application is being developed under Work Package 3 (Task 3.6) and will be released as Deliverable D3.4. Once available, the application is expected to support practical learning activities in areas where XR adds distinct value beyond traditional or purely digital delivery, such as simulations of energy production or renewable infrastructure operation, monitoring of critical infrastructure, and the exploration of design choices in virtual environments. The specific courses in which XR components are embedded, and the depth of that integration, will be determined jointly by the academic partners and the Work Package 3 development team as D3.4 progresses, and will be reflected in Deliverable D3.1 (*Programme Brochure*).

D2.2 therefore recognises XR as a planned element of the AESAI delivery model without committing to a specific course-by-course integration at this stage.

Applied and practice-oriented delivery

Across all delivery modes, the AESAI programme is designed to be practice-oriented and to expose learners to real energy-sector challenges. This includes coding and data analysis assignments (typically using Python and Jupyter notebooks), business and data cases developed with industry partners, project work in small groups on energy problems provided by industry partners, hackathons and industry challenges, work-based learning through internships, and — where appropriate — the use of a virtual laboratory environment for running AI-model experiments. These practice-oriented components are described in more detail in Section 4.2, and the industry co-design principles that underpin them are set out in Section 4.4.

4.2 Industry co-design and industry-collaboration KPIs

Industry engagement is not an add-on to AESAI but a structural feature of the programme design. The industry partners of the AI4GreenDeal consortium participate in curriculum validation through the Industry Advisory Board, contribute real-world datasets, use cases and applied problem statements to the taught courses and online modules, and host applied learning activities directly with students. The blueprint set out in this deliverable is designed to enable — and, where applicable, to contribute towards reaching — the industry collaboration KPIs set out in the Grant Agreement, as summarised in Table 6 below.

#	GA industry-collaboration KPI (by M48)	How the AESAI blueprint enables it	Deliverable(s) that operationalise the KPI
1	Min. 20 guest lectures / seminars by industry experts	Guest lectures are embedded in the taught courses across the four partner universities and in shared components (*Energy and AI: Advanced*; the Business, Innovation & Entrepreneurship journey led by ESADE), and industry contributions are integrated into the online modules catalogue.	WP3 (T3.4); WP4 (T4.3, T4.4)
2	Min. 5 industry data projects	Real-world datasets and use cases contributed by industry partners are integrated into project-based coursework, Master's Theses and challenge-based learning activities across the programme.	WP3 (T3.3); WP4 (T4.4)

3	Min. 2 business cases about industry partners	Business cases are developed with industry partners and integrated into the ESADE-led BIE journey and, where relevant, into taught energy-and-AI courses.	WP3 (T3.3); WP6 (T6.1)
4	Min. 75 mentorships	Industry mentors are engaged through the BIE journey, Master's Thesis supervision arrangements, and the wider InnoEnergy Masters+ ecosystem.	WP4 (T4.6); WP6 (T6.2)
5	Min. 50 students working on industry theses	The 30 ECTS Master's Thesis in Year 2 is designed for delivery in collaboration with an industry or research partner from the AI4GreenDeal consortium (Section 3.1). Thesis-internship arrangements are coordinated under Task 4.6.	WP4 (T4.6); D4.3
6	Min. 10 physical or remote internships	Industry-hosted internships — physical or remote — are facilitated in collaboration with the AI4GreenDeal industry partners and the wider InnoEnergy ecosystem, and are offered as elective components of the Year 2 curriculum at the partner universities in accordance with each institution's academic regulations.	WP4 (T4.6); WP3 (industry engagement in course design)
7	Min. 5 study or lab visits	Study visits to research laboratories and energy facilities across Europe are coordinated under Task 4.5, giving students hands-on exposure to state-of-the-art technologies and infrastructures.	WP4 (T4.5)
8	Min. 5 hackathons and industry challenges	Challenge-based learning activities are co-designed with industry partners and delivered through the taught programme, the online modules and the InnoEnergy ecosystem events (e.g. *ENLIT Europe*, Community+ events).	WP3 (T3.3); WP4 (T4.4)
9	Min. 20 new venture creation projects	The ESADE-led BIE journey (Section 4.3) culminates in a venture-building capstone, supported by the wider InnoEnergy start-up and scale-up ecosystem.	WP6 (T6.1)

Table 6: AI4GreenDeal industry-collaboration KPIs and how the AESAI blueprint enables their delivery.

Of these nine industry-collaboration KPIs, four are enabled directly by the structural choices set out in this deliverable — namely industry-linked Master's Theses (Section 3.1), internships and hackathons and challenge-based learning activities offered as part of the applied and practice-oriented delivery of the programme (Section 4.1), and new venture-creation projects delivered through the ESADE-led Business, Innovation & Entrepreneurship (BIE) journey (Section 4.3). The remaining five KPIs — guest lectures, industry data projects, business cases, mentorships and lab visits — are enabled by the industry-integration principles embedded in the blueprint and will be operationalised through Work Packages 3, 4 and 6, in line with the AI4GreenDeal work plan. Progress against all nine KPIs will be monitored under the AI4GreenDeal governance framework (Deliverable D1.2) and reported through the standard project reporting cycle.

4.3 Innovation and Entrepreneurship Track (ESADE)

A note on terminology — the Business, Innovation & Entrepreneurship (BIE) journey. Throughout the Grant Agreement, the ESADE-led track is referred to as the *Innovation & Entrepreneurship (I&E)* journey. During the detailed design of the track under Work Package 6, the consortium — together with ESADE, which leads the design and delivery of this component — confirmed that its content extends beyond innovation and entrepreneurship in the narrow sense and includes a substantial *Business Management* dimension. To reflect the full scope of the track more accurately, the journey is designated the **Business, Innovation & Entrepreneurship (BIE) journey** in this deliverable and in subsequent project reporting, as well as in recruitment materials, the programme brochure (D3.1) and wider dissemination under Work Package 5. This is a naming refinement only: it does not alter the scope, learning outcomes, delivery model, ECTS-equivalent recognition or GA-committed activities of the journey, and *"BIE journey"* and the Grant Agreement's *"I&E journey"* refer to the same GA-committed activity. A detailed description of the BIE journey — including its structure across the different study periods and delivery modes, the sequence of modules and sessions, their duration, and the main thematic domains covered — is provided in Deliverable D6.1 (*Programme Innovation & Entrepreneurship Strategy Guidelines*), prepared under Work Package 6 and led by ESADE Business School.

The ESADE-led Business, Innovation & Entrepreneurship (BIE) journey is one of the three core themes of AESAI — alongside Energy and Data & AI — and constitutes a structural commitment under the Grant Agreement, which specifies that the 120 ECTS Master's degree is complemented by a BIE certificate awarded by ESADE Business School representing a learning volume equivalent to 10 ECTS. The journey is designed to equip technically trained energy and AI engineers with the entrepreneurial mindset, business acumen and leadership skills required to translate advanced technical work into real-world impact — whether within established industrial organisations, in policy and regulatory environments, or through the creation of new ventures. It also ensures that AESAI graduates are exposed to the business and organisational realities of the twin energy and digital transition, and not solely to its technical dimensions.

Structure of the journey

The ESADE journey is delivered through a combination of face-to-face intensive modules at ESADE Barcelona and at KTH (integrated with the InnoEnergy Masters+ *Connect* event), interleaved with online modules covering strategic and applied topics. In total, the journey accounts for approximately 120 contact hours of learning content, recognised through a dedicated ESADE certificate representing a learning volume equivalent to 10 ECTS. The journey is organised around three domains — *Innovation & Entrepreneurship*, *Business Management*, and *Soft Skills* — with a running Innovation & Entrepreneurship Project that threads through the entire journey and serves as the applied backbone connecting individual sessions.

The journey is delivered in five sequential blocks:

- **November, Year 1 — Face-to-face intensive, ESADE Barcelona (1 week):** Introduction to the *Business, Innovation & Entrepreneurship (BIE) Vision & Project*; entrepreneurship for the green transition in the AI era; market and customer discovery with AI; AI business models; AI business applications; validation strategy principles; and managing high-performance teams in the AI era.
- **Online (winter):** Business strategy in the AI era; BIE Project development; and theory of change.
- **April, Year 1 — Face-to-face intensive, KTH (3 days, integrated with the InnoEnergy Masters+ *Connect* event):** BIE Project workshop; marketing for deep-tech and AI businesses; and scaling operationally.
- **Online (spring):** Innovation for deep-tech strategy; and energy and geopolitics.
- **July, Year 1 — Face-to-face intensive, ESADE Barcelona:** BIE Project workshop; entrepreneurial and business finances; managing intellectual property rights (IPR); managing high-performance teams in the AI era; venture capital essentials for the Green Deal and AI; selling to investors and strategic decision-makers; negotiation; pitching practice and BIE Project tutoring; change management and business simulation; and final BIE Project presentation.

The full session-by-session breakdown, with hours per session and mapping to the three domains, is presented in Table 7.

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Advanced Energy Systems and AI — Business, Innovation & Entrepreneurship (BIE) Detailed Sessions

Period	Day	Teaching Hours	Learning Hours	ESADE Sessions	Domain
Nov Y1 FtoF at ESADE in Barcelona			6	Module preWorks	
	Mo	4	6	Business, Innovation & Entrepreneurship (BIE) Vision & Project	Innovation & Entrepreneurship
	Tu	4	5	Entrepreneurship for Green Transition in the AI Era	Innovation & Entrepreneurship
	Tu	4	5	Entrepreneurship for Green Transition in the AI Era	Innovation & Entrepreneurship
	We	4	6	Market & Customer Discovery with AI	Innovation & Entrepreneurship
	We	3	5	Market & Customer Discovery with AI	Innovation & Entrepreneurship
	Th	4	6	AI Business Models	Business Management
	Th	3	6	AI Business Applications	Business Management
	Fr	3	5	Managing High Performance Teams in the AI Era	Soft Skills
	Fr	3	6	Managing High Performance Teams in the AI Era & QUIZ	Soft Skills
Online	Dec/Jan	2	3	Business Strategy in the AI Era (1/2)	Business Management
	Feb	2	3	Business Strategy in the AI Era (2/2)	Business Management
		2	3	BIE Applied Project Workshop	Innovation & Entrepreneurship
	March	2	3	Theory of Change	Innovation & Entrepreneurship
		2	3	Theory of Change	Innovation & Entrepreneurship
	All period	25		BIE Applied Project Team Work	Innovation & Entrepreneurship
April Y1 FtoF at Masters+ CONNECT in Stockholm at KTH			6	Module PreWork	
	Mo	4	6	BIE Applied Project Workshop	Innovation & Entrepreneurship
	Tu	4	6	Marketing for Deep Tech and AI Businesses	Business Management
	Tu	4	6	Marketing for Deep Tech and AI Businesses	Business Management
	We	4	6	Scale Operationally	Business Management

	We	3	5	Scale Operationally & QUIZ	**Business Management**
Online	**May**	2	3	Innovation for Deep Tech Strategy (1/2)	**Innovation & Entrepreneurship**
		2	3	Innovation for Deep Tech Strategy (2/2)	**Innovation & Entrepreneurship**
	June	2	3	Energy & Geopolitics (1/2)	**Business Management**
		2	3	Energy & Geopolitics (2/2)	**Business Management**
	All period	25		BIE Applied Project Team Work	**Innovation & Entrepreneurship**
July Y1 FtoF at ESADE in Barcelona			10	Module PreWorks	
	Mo	4	6	Entrepreneurial & Business Finances	**Business Management**
	Tu	4	6	Entrepreneurial & Business Finances	**Business Management**
	We	4	6	Entrepreneurial & Business Finances	**Business Management**
		4	6	BIE Applied Project Team Work	**Innovation & Entrepreneurship**
	Th	4	6	Managing IPR — Intellectual Property Rights	**Business Management**
		3	5	Managing High Performance Teams in the AI Era	**Soft Skills**
	Fr	3	5	VC Essentials for Green Deal and AI	**Business Management**
		3	5	"Sell" Investors and Strategic Decision Makers	**Soft Skills**
	Sa	3	6	Negotiation	**Soft Skills**
	Mo	3	5	Pitching	**Soft Skills**
		3	6	Pitching Practice & BIE Applied Project Tutoring	**Soft Skills**
	Th	3	5	Change Management — Business Simulation	**Soft Skills**
		3	5	Change Management — Business Simulation	**Soft Skills**
	We	4	10	BIE Applied Project Presentation & Quiz	**Innovation & Entrepreneurship**
Total teaching hours: 121			**Total: 255**	*10 ECTS credits correspond to approximately 121 teaching hours and between 250 and 300 hours of total participant effort.*	

Domain legend: ■ Innovation & Entrepreneurship ■ Business Management ■ Soft Skills

Table 7: Advanced Energy Systems and AI — Business, Innovation & Entrepreneurship (BIE) detailed sessions

The Grant Agreement specifies four Business, Innovation & Entrepreneurship focused blocks that the programme's BIE component is expected to cover: (i) AI and energy ecosystem and business; (ii) business creation; (iii) business management powered by data and AI; and (iv) leadership for management and transformation, with particular focus on diversity and women leadership. The ESADE journey delivers against each of these four blocks as follows:

- The **AI and energy ecosystem and business** block is covered through *Entrepreneurship for the Green Transition in the AI era*, *AI Business Applications*, *Energy and Geopolitics*, and *Venture Capital Essentials for the Green Deal and AI*, which together situate learners within the specific business ecosystem at the intersection of AI and the energy transition.
- The **business creation** block is covered through the running BIE Project and its supporting sessions — *Market and Customer Discovery with AI*, *AI Business Models*, *Validation Strategy Principles*, *Entrepreneurial and Business Finances*, *Managing Intellectual Property Rights*, *Pitching Practice*, and the final *BIE Project Presentation* — which take learners through the full venture-creation process, from opportunity identification to investor pitch.
- The **business management powered by data and AI** block is covered through *Business Strategy in the AI era*, *Innovation for Deep-Tech Strategy*, *Marketing for Deep-Tech and AI Businesses*, *Scaling Operationally*, and *Change Management – Business Simulation*, which equip learners to operate and grow ventures in an AI-enabled environment.
- The **leadership for management and transformation** block, with its focus on diversity and women leadership, is covered through *Managing High-Performance Teams in the AI era* (delivered in both the November and July intensives), *Theory of Change* and the *Negotiation* module, integrated with the soft-skills domain that runs throughout the journey.

The BIE Project, which threads through the entire ESADE journey and culminates in a graded venture pitch, directly contributes to the Grant Agreement industry-collaboration KPI of a minimum of 20 new venture-creation projects by M48 (Section 4.4). The residential intensive formats at ESADE Barcelona and KTH additionally serve as cohort-building moments across the four AESAI pathways, reinforcing a shared sense of a single AESAI cohort despite students being distributed across four partner universities.

Delivery and recognition

The ESADE journey is designed and delivered by ESADE Business School under Work Package 6, with recognition through a dedicated ESADE certificate awarded upon successful completion of the journey (including the final BIE Project presentation). Together with the 120 ECTS disciplinary diplomas awarded by the two host partner universities, this brings the total learning volume of the AESAI offer to 120 ECTS + a 10 ECTS-equivalent BIE certificate, in line with the Grant Agreement.

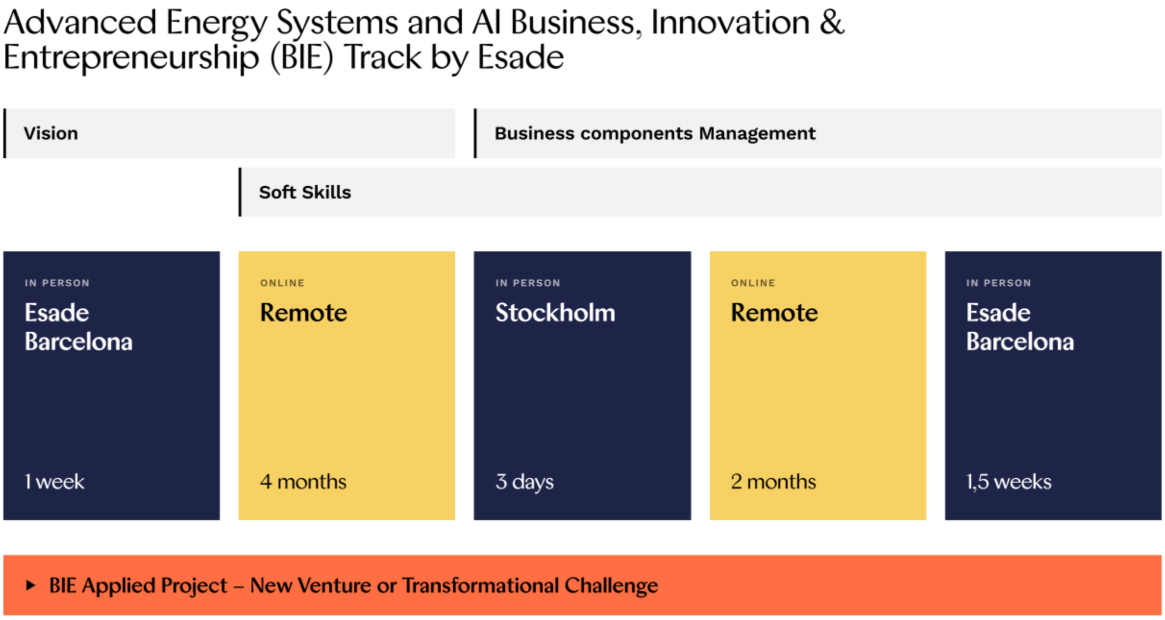

Figure 2: ESADE Business, Innovation & Entrepreneurship Track Overview

The BIE track is delivered as an integrated longitudinal component of the AESAI MSc and is recognised for ECTS credit within each participating university's programme of study. The specific ECTS allocation attributed to the BIE track will be determined by each participating university in accordance with its own institutional academic regulations, credit distribution practices and applicable national frameworks. The final ECTS recognition at each institution will be confirmed in coordination with the respective university faculties, ensuring full alignment with each institution's internal regulations while preserving the coherence and academic integrity of the shared BIE learning experience across the consortium.

Further detail on the AESAI–ESADE Business, Innovation & Entrepreneurship journey — including its structure across the different study periods and delivery modes, the sequence of modules and sessions, their duration, and the main thematic domains covered throughout the learning journey — is provided in Deliverable D6.1 (*Programme Innovation & Entrepreneurship Strategy Guidelines*), prepared under Work Package 6.

4.4 Assessment principles

Assessment across the AESAI programme is expected to be pedagogically aligned with the programme's active, project- and challenge-based learning approach (Section 4.2), the Programme Learning Outcomes formulated at EQF Level 7 (Section 2.2), and the EIT Overall Learning Outcomes (OLOs) reproduced in Appendix D, against which the AESAI curriculum has been cross-checked to support the consortium's intention to apply for the EIT Label in due course. As assessment design falls within the academic autonomy of each partner university and is governed by the applicable national and institutional regulations, this deliverable does not prescribe a single common assessment scheme. Instead, it sets out — at blueprint level — the shared principles that the partner universities have identified as appropriate for the AESAI curriculum, which each institution will implement in line with its own academic rules.

Within this shared framing, partner universities are expected to draw on a mix of continuous and terminal assessment elements, selecting the balance most appropriate to each course's learning outcomes, workload profile and delivery mode.

Continuous assessment approaches may include coding and data analysis assignments (typically using Python and Jupyter notebooks), business and data cases, project work in small groups on energy problems provided by industry partners, hackathons and industry challenges, formative quizzes, readings and reflective tasks, and — for the online modules catalogue (Section 6) — graded exercises and applied assignments embedded within the self-paced content.

Terminal assessment approaches may include written or oral examinations for courses in which consolidated conceptual mastery is a core outcome, capstone assessments (including, for example, the final BIE Project presentation delivered as part of the ESADE Business, Innovation & Entrepreneurship journey — Section 4.3), and the 30 ECTS Master's Thesis at the Year 2 host university, which typically serves as the principal terminal assessment of the double-degree pathway (Section 3.1). Where appropriate and in line with each host university's regulations, thesis and capstone assessments may be evaluated jointly with industry or research partners, consistent with the industry co-design principles set out in Section 4.4.

The specific balance of continuous and terminal assessment for each course, together with the detailed assessment rules, weighting, re-sit arrangements and any credit-conversion or grade-conversion arrangements between partner universities, will be defined by each host institution under its own academic regulations, and will be consolidated for external readers in Deliverable D3.1 (*Programme Brochure*, Milestone 18). D2.2 therefore establishes the assessment principles at blueprint level without prescribing course-by-course assessment design.

5. Curriculum per University

This section provides a complete overview of the AESAI curriculum, grouped by partner university and by phase of the Master's programme, as set out in the tables below. The first three columns identify the course name, the number of ECTS credits and the course type. The fourth column indicates whether the course has changed relative to the EFSC curriculum: *existing* courses are carried over without modification; *changed* courses were already part of the EFSC programme but have been revised to align with the AI4GreenDeal objectives; and *new* courses did not appear in the EFSC catalogue and are either newly developed from scratch or adopted from AI or computer science programmes offered by the local university. The final column specifies the course category, using the same classification adopted in the course tables of Deliverable D2.1 to allow direct one-to-one comparison between the two deliverables.

Under the new AESAI programme, each partner university will offer a full two-year Master's programme. In the previous EFSC configuration, only KU Leuven and KTH Royal Institute of Technology provided full programmes, while Grenoble INP-UGA and UPC BarcelonaTech offered courses in the second year only, and InnoEnergy students could only join the local energy engineering programmes in the second phase. For the new AESAI programme, Grenoble INP-UGA and UPC BarcelonaTech will also welcome InnoEnergy students in the first year of these programmes, which were previously already available for local energy engineering students. Therefore, just like KU Leuven and KTH Royal

Institute of Technology, both of these universities will also make adjustments and additions to their existing energy engineering curriculums in both years.

To ensure a common foundation across the four pathways, courses are maximally harmonised in Year 1. Year 2 course offerings, by contrast, are deliberately diversified in line with the local research and industry strengths of each host university, allowing students to benefit from the full range of specialisation options available across this European Master's programme.

Before turning to the university-specific changes, it is useful to highlight one course addition that is common across all four partner universities. Every partner has added the joint mandatory course *Energy and AI: Advanced* to Year 2 of its curriculum. As a consequence, every AESAI student will take this core course, regardless of the pathway chosen.

5.1 KU Leuven

Year 1

At KU Leuven, the previous EFSC programme offered no flexibility in Year 1, as all courses were mandatory. To introduce greater flexibility in the AESAI programme, a number of Year 1 courses have therefore been modified. Five courses have been reclassified from mandatory to (conditionally) elective. In this context, *conditionally elective* means that three of these four courses must be selected; students are free to substitute one conditionally elective course with another elective course. In addition, the course *Numerical Methods for Electrotechnical Applications* has been halved in size through the removal of its advanced component. For the course *Smart Distribution Systems*, 4 of the 12 lectures have been revised to provide an introduction to machine learning algorithms.

These changes have created room for three new AI-related courses. The first, *Energy and AI: Foundations*, is a mandatory introduction to the energy and AI nexus. The second and third additions, *Artificial Neural Networks and Deep Learning* and *Optimisation*, address advanced topics related to specialised machine learning algorithms.

KU Leuven is also planning to introduce three additional data and AI electives to further increase the flexibility of the curriculum. These changes could not be formally confirmed before the deadline of this deliverable, but are currently on track to be in place by the start of the 2027–2028 academic year. Once approved, they will also bring KU Leuven's total new-course ECTS volume closer to the consortium average, contributing to further harmonisation across the programme.

Course name	ECTS	Type	Status	Category
Power Systems	3	Mandatory	Existing	Energy
Power Electronics	3	Mandatory	Existing	Energy
Energy Markets and Regulation	3	Mandatory	Existing	Energy
Energy Economics	3	Mandatory	Existing	Energy
Nuclear Energy: Basic Aspects	4	Mandatory	Existing	Energy
Renewable Energy	6	Mandatory	Existing	Energy
Thermal Systems: Basic Aspects	3	Mandatory	Existing	Energy
Numerical Methods for Electrotechnical Applications	3	Mandatory	**Changed**	Energy
Smart Distribution Systems	3	Mandatory	**Changed**	Energy/AI
Energy and AI: Foundations	3	Mandatory	**New**	Energy/AI
Technology Entrepreneurship and New Business Development	6	Elective	**Changed**	General
Artificial Neural Networks and Deep Learning	4	Elective	**New**	AI
Optimisation	6	Elective	**New**	AI
Power System Calculations	3	Conditionally Elective	**Changed**	Energy
Combustion Engines	4	Conditionally Elective	**Changed**	Energy
Electrical Drives; Energy Efficiency of Electrical Machines	4	Conditionally Elective	**Changed**	Energy
Energy Challenges	3	Conditionally Elective	**Changed**	Energy

Table 8: KU Leuven curriculum, Year 1 (2027-2028)

Year 2

In Year 2, the KU Leuven specialisation focuses on smart transmission grids, in line with the expertise of the local faculty. As a first change, the content of the course *Optimisation Problems in Energy Systems* has been extended, as this topic is central to the smart optimisation of transmission network flows. Students may also take the course *Artificial Neural Networks and Deep Learning* to build foundational knowledge of neural networks, which is directly applicable to the optimisation and forecasting of transmission system variables. In addition, the course *Electricity and Gas Markets* incorporates several guest lectures covering various aspects of electricity markets, which are essential to the smooth operation of the transmission grid. The course also addresses relevant regulatory topics, featuring contributions from CREG (the Belgian national regulatory body) and ACER (the European Union Agency for the Cooperation of Energy Regulators), both located in Brussels, near Leuven.

To pursue a topic of particular interest, students can choose from a wide range of Master's Thesis topics in the fields of energy, AI or the combination of both. As the thesis carries a weighting of 30 ECTS, students develop substantial expertise in their chosen area.

Course name	ECTS	Type	Status	Category
Master’s Thesis	30	Mandatory	Existing	Energy/AI
Optimisation Problems in Energy Systems	3	Mandatory	**Changed**	Energy/AI
Energy and AI: Advanced	3	Mandatory	**New**	Energy/AI
BIE module	3	Mandatory	**New**	Energy
Design and Management of Electric Power Systems	6	Elective	Existing	Energy
Electromobility	3	Elective	Existing	Energy
Measurement and Testing, including High Voltages	3	Elective	Existing	Energy
Materials in Electrical Engineering	3	Elective	Existing	Energy
Flexible Electrical Power Systems	3	Elective	Existing	Energy
Electrical Energy Conversion for Renewable Energy and Storage	3	Elective	Existing	Energy

Turbulence	3	Elective	Existing	Energy
Aircraft Engines	5	Elective	Existing	Energy
Energy Law	4	Elective	Existing	Energy
Electricity and Gas Markets	3	Elective	Existing	Energy
Industrial Automation and Control	6	Elective	Existing	General
Building Simulations, Part 1	3	Elective	Existing	General
Environmental Economics	3	Elective	Existing	General
Innovation Management and Strategy	6	Elective	Existing	General
Philosophy of Technology	4	Elective	Existing	General
Engineering Economy	3	Elective	Existing	General
ICT Service Management	6	Elective	Existing	General
Introduction to Management and Strategy	4	Elective	Existing	General
Ecodesign and Life Cycle Engineering	3	Elective	Existing	General
Project Management	3	Elective	Existing	General
Experimental Design	4	Elective	Existing	AI
Statistical Data Analysis	6	Elective	Existing	AI
Optimisation	6	Elective	Existing	AI
Artificial Neural Networks and Deep Learning	4	Elective	**New**	AI

Table 9: KU Leuven curriculum, Year 2 (2027-2028)

5.2 KTH Royal Institute of Technology

Year 1

For the AESAI Master's, KTH Royal Institute of Technology has introduced five new Year 1 courses, of which one is mandatory and four are conditionally elective. The mandatory course, *AI Applications in Sustainable Energy*

Engineering, introduces the fundamentals of machine learning in energy engineering and is a central component of the Year 1 common foundation.

The conditionally elective courses may be taken subject to specific conditions: students must be enrolled in the appropriate major, hold the required prerequisites, and the course must be scheduled for delivery in the relevant academic year. Among these, *Machine Learning, Advanced Course* provides foundational insights into specialised machine learning algorithms, while *Electricity Pricing and Emissions* is a valuable addition that combines applied energy problems with solution approaches based on Monte Carlo simulations.

Course name	ECTS	Type	Status	Category
Power System Analysis	6	Mandatory	Existing	Energy
Transdisciplinary Approaches for System Innovations	7.5	Mandatory	Existing	Energy
Heating, cooling and indoor climate	6	Mandatory	Existing	Energy
Renewable Energy Technology	6	Mandatory	Existing	Energy
AI applications in Sustainable Energy Engineering	6	Mandatory	**New**	Energy/AI
Electrical Machines and Drives	6	Elective	Existing	Energy
Communication and Control in Electric Power Systems	7.5	Conditionally elective	Existing	Energy
Electricity Market Analysis	7.5	Conditionally elective	Existing	Energy
Sustainable Power Generation	9	Conditionally elective	**New***	Energy
Electricity Pricing and Emissions	6	Conditionally elective	**New**	Energy
Energy Business	6	Conditionally elective	**New***	Energy
Machine Learning, Advanced Course	7.5	Conditionally elective	**New**	AI

Table 10: KTH curriculum, Year 1 (2027-2028)

****These courses were newly added to replace previous energy courses in line with the course and professor availability at KTH Royal Institute of Technology, but they do not necessarily provide***

additional course content that is relevant for the AI4GD project. Hence, they are not included in Table 3.

Year 2

The KTH Royal Institute of Technology specialisation in Year 2 centres on smart cities, with Stockholm itself serving as a prime example. Three electives underpin this specialisation track. The first is a project-based course, *Smart Cities and Climate Mitigation Strategies*, which offers students hands-on experience in the design and evaluation of smart-city interventions. The second is *Cybersecurity Overview*, which is highly relevant to smart-city applications handling large volumes of personal and operational data. The third is *Computer Applications and Machine Learning in Electric Power Systems*, which addresses machine learning approaches directly relevant to the control layer of smart-city infrastructures.

Next, two conditionally electives courses from year 1 (*Machine Learning, Advanced course* and *Electricity Pricing and Emissions*) are also available in the second year. Together with the newly added course *Integrated Energy Systems for Buildings*, this provides students the flexibility to choose a curriculum that matches their interests, in line with the most recent course availability at KTH Royal Institute of Technology.

Course name	ECTS	Type	Status	Category
Degree Project in Industrial Ecology, Second Cycle	30	Mandatory	Existing	Energy
Degree Project in Electrical Engineering, specialising in Energy Innovation Second Cycle	30	Mandatory	**New**	Energy/AI
Energy and AI: Advanced	3	Mandatory	**New**	Energy/AI
BIE module	3	Mandatory	**New**	AI
Smart Cities and Climate Mitigation Strategies - Project Based	7.5	Mandatory	Existing	General
Management of Projects	7.5	Conditionally Elective	Existing	General
Electricity Pricing and Emissions	6	Conditionally elective	**New**	Energy
Integrated Energy Systems for Buildings	6	Conditionally elective	**New***	Energy

Computer Applications and Machine Learning in Electric Power Systems	7.5	Conditionally elective	**New**	Energy/AI
Cybersecurity Overview	7.5	Conditionally elective	**New**	AI
Machine Learning, Advanced Course	7.5	Conditionally elective	**New**	AI

Table 11: KTH curriculum, Year 2 (2027-2028)

****This course was newly added to replace previous energy courses in line with the course and professor availability at KTH Royal Institute of Technology, but it does not necessarily provide additional course content that is relevant for the AI4GD project. Hence, it is not included in Table 3.***

5.3 Grenoble INP-UGA

Year 1

In Year 1, Grenoble INP-UGA has introduced significant changes to its curriculum, which was previously only taught to local energy engineering students. Four mandatory general-energy courses from the programme have been replaced with four new mandatory courses that align naturally with the AESAI philosophy by blending energy content with AI applications. The most directly relevant addition is *Data Science Fundamentals*, which covers the basics of data processing and provides broad grounding in AI skills. The three other new mandatory courses remain rooted in the energy domain, but incorporate programming-based approaches in their lectures and exercise sessions, thereby contributing to the development of the students' digital competencies.

Grenoble INP-UGA has also introduced four new elective courses to further diversify the possible programme configurations. The most relevant new course for the AI4GreenDeal project is the *Integrative Project*, which allows students to gain applied experience through a supervised independent project. This course offers a valuable opportunity to develop hands-on expertise in the energy sector with a strong digital component.

To further align its curriculum with those of the other partner universities, Grenoble INP-UGA has significantly reduced the number of mandatory and elective French-language credits in its Year 1 offering. This adjustment also provides students with greater flexibility to select engineering courses aligned with their specific interests.

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Course name	ECTS	Type	Status	Category
Energy Economics	5	Mandatory	Existing	Energy
Innovative Components for Smart Grids	5	Mandatory	Existing	Energy
Energy Conversion	5	Mandatory	Existing	Energy
Design and Control of Dynamic Systems	5	Mandatory	**Changed**	Energy
Energy for Eco-Districts	5	Mandatory	**New***	Energy
Multicriteria Sizing of Energy Systems	5	Mandatory	**New***	Energy
Energy control and machines protections	2	Elective	**New***	Energy
Systems Engineering	3	Elective	**New***	Energy
Computer Sciences	5	Mandatory	Existing	AI
Data Science Fundamentals	5	Mandatory	**New**	AI
Modelling and Dispatch of Smart Power	5	Mandatory	**Changed**	Energy/AI
Smart Energy Solutions - Energy for Buildings and Territories	5	Mandatory	**New**	Energy/AI
Electrical grids and decentralisation management	3	Elective	**New**	Energy/AI
Overall Multidisciplinary Project	5	Mandatory	Existing	General
Professional Skills Support, Culture, Employability	0	Mandatory	Existing	General
French Language	2	Elective	**Changed**	General
Integrative Project	2	Elective	**New***	General

Table 12: Grenoble INP-UGA curriculum, Year 1 (2027-2028)
**These courses were newly added to replace previous energy courses in line with the course and professor availability at Grenoble INP-UGA, but they do not necessarily provide additional course content that is relevant for the AI4GD project. Hence, they are not included in Table 3.*

Year 2

In Year 2, the Grenoble INP-UGA specialisation track focuses on the pivotal role of buildings in the energy transition, both as decentralised loads and as large-scale loads. The updated course *Intelligent Distributed Energy Resources* introduces a new focus on data centres, in addition to other distributed energy resources, which increasingly place additional demands on an already stressed electricity grid. Another updated course, Smart Energy Systems, presents specific case studies in which AI applications are used to analyse practical energy systems, including building clusters. The new course *Digital Twins for Energy Systems* addresses the fully digital modelling of energy systems. Additional course revisions in other courses introduce programming-based approaches to classical energy topics, further contributing to the AI4GreenDeal objectives.

Course name	ECTS	Type	Status	Category
Master Thesis	30	Mandatory	Existing	Energy/AI
Smart Energy Systems	5	Mandatory	**Changed**	Energy/AI
Intelligent Distributed Energy Resources	5	Mandatory	**Changed**	Energy/AI
Digital Twins for Energy Systems	3	Mandatory	**New**	Energy/AI
Energy and AI: Advanced	3	Mandatory	**New**	Energy/AI
Economy and Society: Energy Markets	5	Mandatory	**Changed**	Energy
French Language	2	Mandatory	Existing	General
Professional Skills Support	0	Mandatory	Existing	General
BIE module	3	Mandatory	**New**	General
New Sustainable Technologies	5	Elective	Existing	Energy

Energy Management and Energy Efficiency of Buildings	5	Elective	**Changed**	Energy
Dynamics and Grid Stability	5	Elective	**Changed**	Energy
Team Project	5	Elective	Existing	General
Industrial Project	10	Elective	Existing	General
Research Project	10	Elective	Existing	General
Integrative Project	2	Elective	**New***	General
Grids Operation and Planning	5	Elective	**New***	Energy

Table 13: Grenoble INP-UGA curriculum, Year 2 (2027-2028)

****These courses were newly added to replace previous energy courses in line with the course and professor availability at Grenoble INP-UGA, but they do not necessarily provide additional course content that is relevant for the AI4GD project. Hence, they are not included in Table 3.***

5.4 UPC BarcelonaTech

Year 1

The Year 1 curriculum of UPC BarcelonaTech was not previously part of the EFSC Master's, but they already offered a full energy engineering programme to local students, which will now be adopted and adapted for the AI4GD project. In line with the AESAI design, the UPC programme already included a mandatory course, *Data Science Applied to Electrical Energy Systems*, which provides the foundational data processing and machine learning principles required for energy applications. In addition, UPC has revised the project description of an existing course on renewable energy technologies: under the AESAI programme, the project will be required to follow a data-driven approach for AI4GreenDeal students, further supporting the development of their digital competencies.

Course name	ECTS	Type	Status	Category
Centralised Generation and Electrical Networks	5	Mandatory	Existing	Energy
Energy Resources	5	Mandatory	Existing	Energy
Renewable Energy Technologies	5	Mandatory	Existing	Energy

Sustainable Energy and Environment	5	Mandatory	Existing	Energy
Rational and Efficient Use of Energy	5	Mandatory	Existing	Energy
Renewable Energy Projects	5	Mandatory	**Changed**	Energy
Data Science Applied to Electrical Energy Systems	5	Mandatory	Existing	Energy/AI
Energy, Technology, and Society	5	Elective	Existing	Energy
Integration of Renewable Energy into the Electric Grid	5	Elective	Existing	Energy
Introduction to Electric Power Systems	5	Elective	Existing	Energy
Microeconomics and Energy Markets	5	Elective	Existing	Energy
Energy Planning	5	Elective	Existing	Energy
Energy Storage Technologies	5	Elective	Existing	Energy
Hydrogen Technologies	5	Elective	Existing	Energy
Accumulation of Thermal and Thermochemical Energy	5	Elective	Existing	Energy
Biomass Energy	5	Elective	Existing	Energy
Energy Markets	5	Elective	Existing	Energy
Energy Modelling and Climate Policy	5	Elective	Existing	Energy
Hydraulic and Marine Energy	5	Elective	Existing	Energy
Sustainable Building Design	5	Elective	Existing	Energy
Entrepreneurial Competencies	5	Elective	Existing	General

Table 14: UPC BarcelonaTech curriculum, Year 1 (2027-2028)

Year 2

The Year 2 specialisation at UPC BarcelonaTech focuses on smart distribution grids. The core of the specialisation is built around three courses: two mandatory and one core elective. *Artificial Intelligence in Energy Systems* covers advanced AI and deep learning models, with applied programming examples drawn from the energy domain. The new course *Forecasting for Power Systems* introduces students to state-of-the-art forecasting models, with examples focusing on key variables at the distribution grid level. The third course, *Smart Grids*, has been updated to address intelligent control strategies at the low-voltage level.

In addition to these changes, UPC BarcelonaTech has developed a new course, *Data-Driven Challenges for Energy Engineering*. The course *Control and Automation for the Efficient Use of Energy* has also been updated to include data acquisition, processing and storage in databases.

Course name	ECTS	Type	Status	Category
Master's Thesis	30	Mandatory	Existing	Energy/AI
Artificial Intelligence in Energy Systems	5	Mandatory	**Changed**	Energy/AI
Forecasting for Power Systems	5	Mandatory	**New**	Energy/AI
Energy and AI: Advanced, BIE module	5	Mandatory	**New**	Energy/AI
Energy, Technology, and Society	5	Elective	Existing	Energy
Integration of Renewable Energy into the Electric Grid	5	Elective	Existing	Energy
Introduction to Electric Power Systems	5	Elective	Existing	Energy
Microeconomics and Energy Markets	5	Elective	Existing	Energy
Energy Planning	5	Elective	Existing	Energy
Energy Storage Technologies	5	Elective	Existing	Energy
Hydrogen Technologies	5	Elective	Existing	Energy
Accumulation of Thermal and Thermochemical Energy	5	Elective	Existing	Energy
Biomass Energy	5	Elective	Existing	Energy
Energy Markets	5	Elective	Existing	Energy
Energy Modelling and Climate Policy	5	Elective	Existing	Energy

Hydraulic and Marine Energy	5	Elective	Existing	Energy
Sustainable Building Design	5	Elective	Existing	Energy
Wind Power	5	Elective	Existing	Energy
Electric Energy Conversion	5	Elective	Existing	Energy
Energy Management and Optimisation of Electrical Power Systems	5	Elective	Existing	Energy/AI
Entrepreneurial Competencies	5	Elective	Existing	General
Control and Automation for the Efficient Use of Energy	5	Core elective	**Changed**	Energy/AI
Smart Grids	5	Core elective	**Changed**	Energy/AI
Data-Driven Challenges for Energy Engineering	5	Core elective	**New**	Energy/AI
Futures Thinking and Ideation for Energy Projects	5	Core elective	Existing	General
Prototyping for Energy Projects	5	Core elective	Existing	General

Table 15: UPC BarcelonaTech curriculum, Year 2 (2027-2028)

6. Self-standing Modules and Micro-credentials

6.1 Catalogue and dual-use design

Under the Grant Agreement, the AI4GreenDeal consortium is committed to designing and delivering approximately 238 learning hours of online learning content. This content is structured as a catalogue of self-standing, stackable modules rather than as a single monolithic course, so that each module can be studied, assessed and certified independently, while remaining part of a coherent overall learning offer aligned with the InnoEnergy *Data Science for*

Energy Engineers skills framework and the four skill gaps identified in Deliverable D2.1.

Each module in the catalogue is designed to be usable in two complementary ways:

- **Embedded in AESAI courses (blended use):** Individual modules may be integrated within the taught programme as digital learning components of a blended course, providing shared foundational content, flipped-classroom material or advanced elective units across the four partner universities. This ensures that all AESAI students, regardless of host institution, have access to the same high-quality digital content on core topics such as responsible AI use, foundational data science and AI methods, and advanced specialised research areas.
- **Offered stand-alone to professionals:** The same modules are offered as self-standing units to a wider audience of working professionals, career-changers and lifelong learners in the energy sector. Learners can enrol in individual modules to build specific competencies, or combine multiple modules into structured learning pathways leading to professional certification, in line with the project's target of 300 professional-certificate learners by M48.

Appendix A: Online Stackable *Module Catalogue* lists the modules currently included in the catalogue, indicating the owning consortium partner responsible for design, content, quality assurance and updates for each module. Where a module is jointly developed, all contributing partners are listed together. Full descriptors for each module, following the standard descriptor template, are also provided in Appendix A.

Together, the modules account for the approximately 238 hours of online learning content committed under the Grant Agreement. The dual-use design — embedded in AESAI courses and offered stand-alone to professionals — maximises the value of each hour of content produced, strengthens the coherence between the degree pathway and the professional certification offer, and supports the project's broader ambition of broadening access to advanced data and AI skills for the European energy transition.

The catalogue presented in Appendix A is a blueprint version and remains subject to change: consortium partners are closely monitoring developments in AI, data science and the energy sector, and will adjust module topics, subject matter experts, content and emphasis as appropriate to ensure that learners consistently receive high-quality, up-to-date material.

6.2 Stackability and recognition

Each online module in the catalogue (Section 6.1) is designed as a compact unit of learning, typically representing 25–30 hours of total learner effort and corresponding to 1 ECTS in line with the standard Bologna workload convention. This compact unit size enables learners to build competencies incrementally, ensures that content can be revisited and updated with reasonable effort, and supports flexible combinations across learning pathways. Two ESADE modules addressing industrial and start-up perspectives on the Green Deal are shorter, at 20 and 10 hours respectively, and are recognised proportionally at 0.67 and 0.33 ECTS under the same convention. The full catalogue accounts for approximately 238 hours of online learning content committed under the Grant Agreement.

The catalogue is designed as a stackable offer, meaning that modules can be combined by learners into coherent learning pathways rather than being taken solely as isolated units. Within the AESAI Master's programme, individual modules may be embedded in taught courses as blended learning components, or considered as elective units contributing to the overall 120 ECTS, in accordance with the academic regulations of the host partner university. For learners approaching the programme through the professional route, a defined set of stacked modules — combining foundational, specialised and cross-cutting content — is intended to constitute a recognised learning pathway. Where a learner subsequently enrols in the full AESAI Master's, prior learning acquired through the modules may be recognised through the standard Recognition of Prior Learning (RPL) mechanisms of the partner universities, subject to the applicable national and institutional regulations.

In line with the Grant Agreement, the consortium will strive to offer the self-standing modules in a form that supports their combination towards credits for the 120 ECTS degree programme. During the project, the consortium will explore a range of options for the formal recognition of module completion — including, but not limited to, professional certificates issued under the InnoEnergy Masters+ framework and micro-credential formats aligned with the *Council Recommendation of 16 June 2022 on a European approach to micro-credentials for lifelong learning and employability*. The selection of the most appropriate recognition instrument for each module will be informed by the academic regulations and quality assurance frameworks of the partner universities, the requirements of the target learner audiences, and the outcomes of the ongoing consortium work under Work Package 2. No specific certification format is committed to at this stage of the project.

Regardless of the recognition instrument ultimately adopted, the design of the catalogue is grounded in the core Bologna principles of transparency, comparability and learner mobility. Learning outcomes are expressed at EQF Level 7 and mapped to the European Skills, Competences, Qualifications and Occupations (ESCO) classification; workload is expressed in ECTS in line with the ECTS Users' Guide (Appendix A: Online Stackable Module Catalogue); quality assurance is carried out under each partner university's national QA framework; and any recognition of prior learning is managed through the partner institutions' existing Bologna-compliant procedures.

As part of the consortium's exploration of recognition instruments referenced above, the AI4GreenDeal partners may also engage with international university associations to inform their thinking. In particular, UPC BarcelonaTech and Grenoble INP-UGA and KTH are partner institutions in the *Unite!* European University Alliance, which has been developing practice on joint programmes and micro-credentials across its member universities. In line with Task 2.4 of the Grant Agreement, the consortium may draw on relevant experience and emerging practice from *Unite!* and similar alliances as one input, among others, into its work on the recognition of the AESAI online modules. Any such engagement will remain exploratory in nature during the project and does not entail a commitment to a specific joint-degree or micro-credential format at this stage.

6.3 Target professional learners

Alongside the 120 ECTS AESAI Master's programme, the AI4GreenDeal offer explicitly targets working professionals in need of upskilling and reskilling for the twin energy and digital transition. This audience is central to the project's rationale: the four skill gaps identified in Deliverable D2.1 — broad AI literacy, digital thinking in energy systems, specialised algorithm knowledge, and big data analytics — are as pressing for practitioners already active in the energy sector as they are for new engineering graduates. The self-standing online modules described in Section 6.1 are therefore designed to meet the needs of professionals who cannot commit to a full Master's programme but who require targeted, flexible and applied learning to remain effective in a rapidly evolving field.

Within this broad category, the offer is designed with three principal professional learner profiles in mind:

- **Upskilling profile — energy professionals developing digital and AI competencies:** Engineers, analysts and technical specialists already working in the energy sector who need to build applied AI, data science and digital-thinking capabilities on top of an existing energy engineering or scientific background.
- **Reskilling profile — professionals transitioning into the energy sector:** Data scientists, software engineers, consultants and other digitally literate professionals who wish to reorient their careers towards the energy transition and require targeted grounding in energy systems, market dynamics and applied use cases.
- **Ecosystem and adjacent profile — innovation, entrepreneurship and management practitioners:** Founders, product managers, sustainability leads and policy professionals working in cleantech companies, utilities, regulators and industrial organisations who need to understand the strategic, ethical and organisational implications of AI adoption in the energy sector.

Four design choices make the offer well suited to these target audiences: (i) modules are compact (typically 1 ECTS, or 25–30 hours), enabling learners to progress in short, manageable increments alongside professional commitments; (ii) content is delivered asynchronously online, removing geographical and scheduling barriers to participation; (iii) modules are developed in close collaboration with the project's industry partners and grounded in real-world datasets and use cases, ensuring immediate professional relevance; and (iv) modules are stackable into coherent learning pathways (Section 6.2), allowing professionals to build recognised competencies over time in a way that supports both individual career development and employer-sponsored workforce development.

Contribution to the 300 professional-certificate KPI

Under the Grant Agreement, AI4GreenDeal is committed to reaching a minimum of 450 learners across its Master's and self-standing module offerings by M48. The online modules catalogue is the primary vehicle through which this KPI will be met, complementing the degree pathway (which contributes towards the 150 degree-student target). The consortium will support achievement of the 300-learner target through a combination of the following channels:

- targeted marketing and communication activities coordinated under Work Package 5, addressing the three professional learner profiles above;
- dissemination of the modules through relevant EU portals and platforms — including the Europass platform, the EU Academy, the European Digital Skills and Jobs Platform, and other Digital Europe Programme communication channels — to maximise visibility across EU Member States and associated countries;
- direct promotion to the InnoEnergy alumni community of more than 2,200 certified energy engineers, whose professional profiles and appetite for continuous learning make them a natural audience for the offer;
- partnerships with the project's industry partners and the wider InnoEnergy ecosystem of supported start-ups, scale-ups and industrial members, to channel employer-sponsored learners into the offer;
- engagement with the university networks of the four partner institutions, including — where relevant — the *Unite!* European University Alliance in which UPC BarcelonaTech and Grenoble INP-UGA are partner institutions, to reach adjacent professional audiences; and
- progressive scaling of enrolment across successive intake cycles as the module catalogue is completed, published and iterated over the course of the project.

Progress against the 300-learner KPI will be monitored under the AI4GreenDeal governance framework (Deliverable D1.2) and reported through the standard project reporting cycle.

During the AI4GreenDeal project period, the self-standing online modules are not commercialised: they are offered free of charge to professional learners, in line with the project's commitment to broaden access to advanced data and AI skills for the European energy transition. The absence of a fee removes the primary financial barrier to participation and directly supports the reach targeted for the 300 professional-certificate learner KPI (above).

Should an FSTP mechanism become relevant to the online modules — for example, in the form of limited mobility or participation support for professional learners engaging with residential or blended elements of the offer — such support should be managed under WP4 (Task 4.0) and remains subject to Digital Europe Programme eligibility rules (Section 3.4). Long-term arrangements for the online modules beyond the project period, including any future access, subscription or professional-certification model, will be defined under the financial sustainability work led by ESADE in WP6 (D6.3) and are outside the scope of this deliverable.

7. Quality, Coherence and Inclusion

7.1 Coherence across pathways

Coherence across AESAI's twelve possible double-degree pathways (Section 3.2, Table 5) is secured through a set of common elements that apply regardless of which two partner universities a student combines. All four partners deliver the same Programme Learning Outcomes, defined once at EQF Level 7 and organised around the same three core themes — Energy, Innovation & Entrepreneurship, and Data & AI (Section 2.2) — rather than each institution defining its own outcomes independently. All four partners deliver the same joint mandatory course, *Energy and AI: Advanced*, in Year 2 (Section 2.4, Table 3), and all four integrate the same ESADE Business, Innovation & Entrepreneurship journey (Section 4.3). The credit-progression rules governing movement from Year 1 to Year 2 are likewise common across the consortium, with the single documented exception of Grenoble INP-UGA's stricter 60 ECTS requirement, which is applied in accordance with French national regulation (Section 3.2).

What is deliberately allowed to vary per partner university is the Year 2 specialisation track and thematic focus — *Artificial Intelligence and Smart Transmission Systems* at KU Leuven, *AI for Smart Distribution Grids* at UPC BarcelonaTech, *AI for Energy Systems in Smart Cities* at KTH Royal Institute of Technology, and AI for Distributed Energy Resources at Grenoble INP-UGA (Section 3.1) — together with the specific local courses each partner uses to deliver the shared outcomes (Section 5). This balance ensures that every graduate holds a comparable and coherent qualification, regardless of pathway, while continuing to benefit from each host institution's distinct research and industry strengths.

7.2 Equity and inclusion

Equity and inclusion are structural design principles of the AESAI programme rather than downstream considerations, and are anchored in the specific commitments made by the AI4GreenDeal consortium under the Grant Agreement.

The Grant Agreement commits the project to reaching, by M48:

- a minimum of 30 % female learners or learners from lower socio-economic backgrounds across the degree programme, the self-standing modules and the FSTP-supported cohorts combined;
- a minimum 80 % course completion rate across the degree programme and the self-standing modules, to ensure that inclusive recruitment translates into inclusive graduation outcomes;
- and up to 250 beneficiaries of financial or other support through the Financial Support to Third Parties (FSTP) mechanism, funded from a dedicated €2 million envelope managed by ISE under WP4. In line with Digital Europe Programme rules, FSTP support is available only to applicants and learners who hold the nationality of an EU Member State or of another Digital Europe Programme eligible country (or, where applicable, meet the residency criteria set out in the FSTP call). Applicants from countries outside the DEP eligibility scope may still be admitted to the programme where academic and administrative criteria are met, but are not eligible for FSTP-funded fee waivers and mobility support.

The programme design set out in this deliverable is intentionally shaped to make these targets reachable:

- ***English-language delivery* (Section 4.1):** Delivery entirely in English removes local-language barriers to entry at any of the four partner universities and enables recruitment across EU Member States, associated countries and eligible third countries under the Digital Europe Programme.
- ***Predictable pathway selection and mobility rules* (Section 3.2):** Full pathway allocation at the point of admission, together with explicit capacity constraints and progression rules, ensures that pathway choice does not silently disadvantage students at less-resourced partners or students requiring visa or relocation planning.
- ***Flexible, low-barrier professional learner offer* (Section 6.3):** The stackable online modules catalogue is designed to be accessible to working professionals, career-changers and learners in geographies or life circumstances that make full-time on-campus study infeasible,

broadening the demographic base beyond the traditional Master's applicant pool.
- ***Financial accessibility through FSTP for DEP-eligible applicants* (Section 3.4):** For applicants and learners from EU Member States and other Digital Europe Programme eligible countries, the FSTP mechanism operationalised under WP4 (Task 4.0) and reported through D4.1 is the primary instrument by which the consortium ensures that financial capacity is not a barrier to participation. Scholarships, fee waivers and mobility budgets are allocated through published FSTP calls, with selection criteria designed to support the project's 30 % inclusion threshold across gender, socio-economic background and geographic origin within the DEP-eligible learner population.

Beyond access, retention and belonging matter for the 80 % completion KPI. The AESAI blueprint incorporates two shared cross-cohort experiences — the ESADE Business, Innovation & Entrepreneurship journey with residential moments in Barcelona and Stockholm (Section 4.3), and the joint mandatory course *Energy and AI: Advanced* co-delivered by all four partner universities (Section 4.1) — which give students distributed across four host institutions a shared sense of cohort identity, peer network and belonging over the two years of the programme.

Female participation, teaching staff and role models

The AI4GreenDeal work plan additionally commits the consortium to attracting female teaching staff and experts, activating female role models to promote the programme through networks such as *Women in Data Science Worldwide*, and giving priority to female applicants in the allocation of mobility budgets and teacher-training opportunities. Within the ESADE BIE journey, dedicated content on diversity and women in leadership is embedded through the *Managing High-Performance Teams in the AI era* and *Leadership for Management & Transformation* components (Section 4.3), in line with the "leadership for management and transformation with particular focus on diversity and women leadership" BIE block committed in the Grant Agreement.

Baseline and monitoring

Formal demographic baselines for the AESAI cohort — including gender balance, socio-economic background distribution, geographic origin and completion rates — will be established once the first intake enrols in the 2027 academic year, and will be tracked and reported under the AI4GreenDeal governance framework (D1.2) through the standard project reporting cycle.

Progress against the 30 % inclusion target and the 80 % completion target will be reviewed at each intake cycle, and adjustments to admission communications, FSTP allocation criteria and cohort support will be considered by the Programme Steering Committee where needed to keep the project on track against these KPIs.

7.3 Handover to accreditation and dissemination

The structural and delivery design set out in this deliverable feeds directly into Deliverable D2.3 (*Accreditation Plan and Agreement*, Milestone 18), which will carry the accreditation-related work for the four partner universities forward from the blueprint established here. D2.3 is expected to consider recognition at two levels: (i) the accreditation pathways for the 120 ECTS AESAI double-degree under each partner university's national quality assurance framework; and (ii) the range of recognition options that may be applied to the catalogue of self-standing online modules (Section 6.2), which the consortium will continue to explore over the course of the project without committing to a specific format at this stage.

As foreseen in Task 2.4 of the Grant Agreement, D2.3 may also draw on the consortium's engagement with international university associations, including the *Unite!* European University Alliance in which UPC BarcelonaTech and Grenoble INP-UGA, and KTH are partner institutions. *Unite!* and similar alliances offer a useful point of reference for the consortium's thinking on joint programmes and micro-credentials, and any experience relevant to AESAI may inform the accreditation approach considered in D2.3. This engagement is exploratory in nature and does not entail a specific accreditation or recognition commitment at this stage of the project.

In parallel, the programme structure, curriculum and mobility model described in this report will inform Deliverable D3.1 (*Programme Brochure*, Milestone 18) and will be shared through relevant EU dissemination channels — such as the European Digital Skills and Jobs Platform and the Europass platform — as part of the project's marketing and communication activities under Work Package 5.

8. Conclusion and Next Steps

This deliverable presents the complete structural blueprint for the Master's in Advanced Energy Systems and AI (AESAI): a 120 ECTS double-degree Master's, complemented by a 10 ECTS-equivalent Innovation & Entrepreneurship certificate awarded by ESADE Business School, built on a common Year 1 foundation and four university-specific Year 2 specialisation tracks (Section 3), consistent means of delivery across all four partner universities grounded in active, project- and challenge-based learning with strong industry co-delivery (Section 4), the detailed per-university curriculum for KU Leuven, KTH Royal Institute of Technology, Grenoble INP-UGA and UPC BarcelonaTech (Section 5), and a complementary catalogue of approximately 238 hours of stackable online modules addressed to both AESAI students and professional learners (Section 6). Together, these components directly address the four skill gaps validated in Deliverable D2.1 — broad AI literacy, digital thinking in energy systems, specialised algorithm knowledge, and big data analytics — while preserving coherence across all twelve possible double-degree pathways (Section 7).

The blueprint is designed from the outset to deliver against the KPIs set in the Grant Agreement: a minimum of 150 students graduated or enrolled in the AESAI degree programme and 300 learners enrolled in the self-standing modules by M48, together with the accessibility and inclusion targets of 30 % female learners or learners from lower socio-economic backgrounds, a minimum 80 % completion rate, and up to 250 beneficiaries of financial or other support through the Financial Support to Third Parties (FSTP) mechanism managed under Work Package 4. Industry engagement is embedded structurally in the design, and the blueprint is aligned with the industry-collaboration KPIs set out in the Grant Agreement (Section 4.4).

D2.2 fulfils Milestone 6 of the AI4GreenDeal project — *"Defined programme structure and means of delivery at each of the partner universities"* — and provides the foundation on which subsequent WP2 and WP3 work is built. The immediate next steps are as follows:

- **Deliverable D2.3 (Accreditation Plan and Agreement, Milestone 18):** The accreditation-related work for the four partner universities will be carried forward from the blueprint established here, including consideration of recognition options for the self-standing online modules catalogue and, where relevant, exploratory engagement with international university associations such as the *Unite!* European University Alliance (Section 7.3).
- **Deliverable D3.1 (Programme Brochure, Milestone 18):** The programme structure, curriculum, mobility model and assessment principles set out in this report will be consolidated for external audiences in the

Programme Brochure and shared through relevant EU dissemination channels.
- **Work Package 3 (Programme Development):** WP3 will develop the detailed content for the new and modified courses and for the online modules catalogue (Deliverables D3.1–D3.4), including the asynchronous online learning materials for the ~238 hours of stackable content and the XR learning application.
- **Work Packages 4, 5 and 6:** WP4 will operationalise programme delivery, admissions, FSTP allocation and student administration; WP5 will lead the dissemination, marketing and recruitment campaigns needed to reach the KPI targets; and WP6 will continue to develop the Innovation & Entrepreneurship journey, alumni network and sustainability strategy that underpin the long-term viability of the offer.
- **Consortium-level follow-up:** A small number of items flagged in this deliverable — including the final harmonisation of Grenoble INP-UGA's Year 1 course load with the 60 ECTS national requirement and the confirmation of per-cohort intake targets by the Programme Steering Committee — will be closed out ahead of the first AESAI intake.

Taken together, the blueprint set out in this deliverable positions AI4GreenDeal to launch the first AESAI cohort in the 2027–2028 academic year, and to reach the full learner and inclusion targets set in the Grant Agreement by the end of the project period in June 2029.

Appendix A: Online Stackable Module Catalogue

The online stackable module catalogue presented here is a blueprint version and is subject to change: consortium partners are closely monitoring developments in AI, data science and the energy sector, and will adjust module topics, content and emphasis as appropriate to ensure that learners consistently receive high-quality, up-to-date material. (1 ECTS ≈ 25–30 h). Learning outcomes are expressed at EQF Level 7 and mapped to the European Skills, Competences, Qualifications and Occupations (ESCO) classification, in line with the Programme Learning Outcomes set out in Section 2.2.

Module 1

Module title & code	AI for Innovation and Entrepreneurship
ECTS	1
Owning university / partner	ESADE
Language of instruction	English
Module learning outcomes (assessable)	• Explain how generative and agentic AI work as a no-maths mental model, and frame tasks as outcomes rather than tool features. • Stay current in a fast-moving field, and decide when to adopt, park or ignore a tool, and when to buy versus build. • Build with AI without code: engineer context, ground AI in own documents, and direct multi-step, plain-language automations and agents. • Design and run a personal AI operating system ("second brain") that compounds knowledge. • Turn core founder and operator workflows into reusable AI workflows and assemble them into a venture operating system. • Deconstruct AI-native business models and apply their principles to an energy venture.

	• Ship one working, governed AI workflow under EU AI Act and responsible-AI guardrails, keeping a human in the loop.
Linked Programme Learning Outcome(s) / skill gap	• Skill gap: Broad AI literacy
Workload breakdown (contact vs. self-study hours = ECTS)	Total: 30 h = 1 ECTS
Subject Matter Expert(s)	Gabriel Chouchane (ESADE)

Module 2

Module title & code	Responsible Use of AI
ECTS	1
Owning university / partner	InnoEnergy
Language of instruction	English
Module learning outcomes (assessable)	• Analyse contemporary perspectives on human–AI collaboration and evaluate how AI can be used to optimise knowledge creation, critical thinking, innovation and decision-making while preserving human agency and judgement. • Critically and effectively use generative AI to support learning and professional tasks through workflow design, multimodal AI techniques and AI-supported productivity practices. • Recognise anthropomorphisation, over-reliance and psychological risk patterns in own and peers' AI use, and apply strategies to maintain healthy boundaries. • Analyse the energy, water and carbon footprint of AI systems, and connect data-centre sustainability challenges to opportunities in the energy transition. • Apply institutional AI policies, disclose AI assistance appropriately, and judge what data is safe to share with AI tools in academic and professional contexts.

	• Develop a reflective, informed and evidence-based personal approach to responsible AI use in study, work and everyday life.
Linked Programme Learning Outcome(s) / skill gap	• Skill gap: Broad AI literacy
Workload breakdown (contact vs. self-study hours = ECTS)	Total: 25–30 h = 1 ECTS
Subject Matter Expert(s)	Inge de Waard (InnoEnergy)

Module 3

Module title & code	Joint introductory course on energy, data science and AI
ECTS	1
Owning university / partner	KU Leuven, Grenoble INP-UGA, UPC BarcelonaTech (jointly taught)
Language of instruction	English
Module learning outcomes (assessable)	• Explain the core concepts in AI and data science and how they interact with the modern energy system. • Describe core algorithms — supervised and unsupervised learning, forecasting, transfer and federated learning — and how they work under the hood. • Identify the practical challenges that arise in the application of off-the-shelf models to energy problems. • Explain core concepts of optimisation and optimal decision-making, and how AI and data science can inform decisions. • Analyse practical case studies illustrating how energy and AI systems interact in an increasingly connected world.
Linked Programme Learning Outcome(s) / skill gap	• Primary skill gap: Specialised algorithms • Secondary skill gap: Broad AI literacy

Workload breakdown (contact vs. self-study hours = ECTS)	Total: 30 h = 1 ECTS
Subject Matter Expert(s)	Marc Jené (UPC), Oscar Cabrera (UPC); joint faculty from KU Leuven and Grenoble INP-UGA

Module 4

Module title & code	Specialised module – KU Leuven (energy flexibility, value-oriented and hierarchical forecasting, causal ML, physics-informed neural networks)
ECTS	1
Owning university / partner	KU Leuven
Language of instruction	English
Module learning outcomes (assessable)	• Explain how demand-side flexibility will form a vital part of future energy systems, and the challenges of operationalising it using distributed and large loads. • Define how energy flexibility is quantified, predicted, measured and verified in practice by utilities and grid operators. • Motivate why prediction problems are increasingly interleaved with downstream decision-making, and formulate core value-oriented forecasting techniques (decision-focused learning, predict-and-optimise). • Explain the hierarchical coherency challenge in energy forecasting and the algorithms developed to address it. • Identify the causality gap in classical machine learning and introduce causal ML algorithms with applications to energy systems. • Explain how causality can be ensured using physics-informed neural networks in supervised and unsupervised learning problems.
Linked Programme Learning Outcome(s) / skill gap	• Primary skill gap: Specialised algorithms • Secondary skill gap: Digital thinking in energy systems

Workload breakdown (contact vs. self-study hours = ECTS)	Total: 30 h = 1 ECTS
Subject Matter Expert(s)	Xiaoyu Jin, Cuiling Wang, Fereshteh Poormohammadi (KU Leuven); contributing faculty: Maria Margarida Mascarenhas, Arnaud Verstraeten, Joris Depoortere, Talia Qaiser, Fuyang Jiang, Sina Toghranegar

Module 5

Module title & code	Specialised module – UPC (optimisation for data-centre demand response, physics-informed neural networks, conditional diffusion modelling, data-driven grid reinforcement, topology identification)
ECTS	1
Owning university / partner	UPC BarcelonaTech
Language of instruction	English
Module learning outcomes (assessable)	• Explain how data centres can provide demand flexibility to power systems, and formulate the main elements of a demand-response optimisation problem. • Formulate decision variables, objectives, constraints and external signals for demand-side flexibility. • Explain how physical laws, operational constraints and augmented Lagrangian formulations can be embedded into neural network training for power system applications, and formulate a basic physics-informed learning problem. • Describe the principles of generative AI models with a focus on conditional diffusion models, and identify electrical engineering problems where they can support scenario generation, forecasting, uncertainty representation or data augmentation. • Explain how data-driven methods can support grid planning and reinforcement decisions under uncertainty in demand, generation and electrification. • Explain the topology identification problem in low-voltage distribution networks, with emphasis on phase identification, and describe how smart-meter and

	network measurements can be analysed to infer customer-to-phase connectivity.
Linked Programme Learning Outcome(s) / skill gap	• Primary skill gap: Specialised algorithms • Secondary skill gap: Big data analytics
Workload breakdown (contact vs. self-study hours = ECTS)	Total: 30 h = 1 ECTS
Subject Matter Expert(s)	Marc Jené, Oscar Cabrera (UPC); contributing faculty: Adriano Caprara, Antonio Saldaña, Marc Carrillo, Engy Sameer

Module 6

Module title & code	Data Science Case Studies
ECTS	1
Owning university / partner	Grenoble INP-UGA
Language of instruction	English
Module learning outcomes (assessable)	• Implement and evaluate machine learning algorithms in a Smart Grid or Smart City context. • Explain the key concepts related to Big Data and their importance in Smart Grid management. • Exploit massive datasets to extract useful information for supervision or decision-making in Smart Grids. • Design or interpret SCADA architectures adapted to Smart Grid requirements. • Identify and integrate home automation solutions within the framework of an intelligent building. • Design energy management scenarios on a housing scale using home automation equipment.
Linked Programme Learning Outcome(s) / skill gap	• Primary skill gap: Big data analytics • Secondary skill gap: Digital thinking in energy systems

Workload breakdown (contact vs. self-study hours = ECTS)	Total: 30 h = 1 ECTS
Subject Matter Expert(s)	Alexander Carr, Antoine Labonne, Muhammad-Salman Shahid, Benoit Delinchant, Thierry Braconnier (Grenoble INP-UGA)

Module 7

Module title & code	The past, present and future of energy systems in Belgium, Spain and France
ECTS	1
Owning university / partner	KU Leuven, UPC BarcelonaTech, Grenoble INP-UGA (jointly taught)
Language of instruction	English
Module learning outcomes (assessable)	• Explain how the energy system in Belgium has evolved over recent decades and will continue to do so, and the role data and AI have played and will play in that evolution. • Explain how the energy system in Spain has evolved over recent decades and will continue to do so, and the role data and AI have played and will play in that evolution. • Explain how the energy system in France has evolved over recent decades and will continue to do so, and the role data and AI have played and will play in that evolution.
Linked Programme Learning Outcome(s) / skill gap	• Skill gap: Digital thinking in energy systems
Workload breakdown (contact vs. self-study hours = ECTS)	Total: 25–30 h = 1 ECTS
Subject Matter Expert(s)	Johan Driesen (KU Leuven); UPC and Grenoble INP-UGA leads TBC

Module 8

Module title & code	AI and the Green Deal: Industrial Perspective
ECTS	0.67 (20 h at 30 h per ECTS)
Owning university / partner	ESADE
Language of instruction	English
Module learning outcomes (assessable)	• Understand how AI is being applied in the energy and industrial sectors through real-world cases, industry datasets and examples from leading companies. • Recognise the key stages, opportunities and challenges of AI implementation in industrial environments, from pilot projects to large-scale deployment. • Develop an industry-oriented innovation mindset, understanding how AI creates value for businesses while addressing sustainability and regulatory requirements. • Build connections with industry, gaining insights into innovation ecosystems and future collaboration opportunities.
Linked Programme Learning Outcome(s) / skill gap	• Primary skill gap: Digital thinking in energy systems • Secondary skill gap: Broad AI literacy
Workload breakdown (contact vs. self-study hours = ECTS)	Total: 20 h = 0.67 ECTS (ESADE convention: 30 h per ECTS)
Subject Matter Expert(s)	TBD (ESADE)

Module 9

Module title & code	AI and the Green Deal: Startup Case
ECTS	0.33 (10 h at 30 h per ECTS)
Owning university / partner	ESADE

Language of instruction	English
Module learning outcomes (assessable)	• Recognise the key opportunities of AI implementation from idea to company creation and scaling. • Learn from successful cleantech startups by analysing how innovative technologies are developed, scaled and commercialised in the energy transition sector. • Build connections with startup professionals, gaining insights into innovation ecosystems and future collaboration opportunities.
Linked Programme Learning Outcome(s) / skill gap	• Primary skill gap: Broad AI literacy • Secondary skill gap: Digital thinking in energy systems
Workload breakdown (contact vs. self-study hours = ECTS)	Total: 10 h = 0.33 ECTS (ESADE convention: 30 h per ECTS)
Subject Matter Expert(s)	TBD (ESADE)

Appendix B: Double-degree pathway matrix

This appendix lists every valid entry→exit combination across the four AESAI partner universities and the two degrees awarded on successful completion. It demonstrates that the per-university curricula interlock into coherent 120 ECTS double-degree pathways. Official degree titles are those registered by each partner university under its national accreditation framework; both original-language and English titles are recognised.

#	Entry university (Y1)	Specialisation university (Y2)	Degrees awarded on completion	Notes
1	KU Leuven	UPC BarcelonaTech	KU Leuven: Master of Engineering: Energy UPC: Master of Energy Engineering	.
2	KU Leuven	Grenoble INP-UGA	KU Leuven: Master of Engineering: Energy Grenoble INP-UGA: International Master of Science in Electrical Engineering for Smart Grids and Buildings	French national rule applies: full 60 Y1 ECTS required before Y2 enrolment.
3	KU Leuven	KTH Royal Institute of Technology	KU Leuven: Master of Engineering: Energy KTH: Master of Science (120 credits)	
4	UPC BarcelonaTech	KU Leuven	UPC: Master of Energy Engineering KU Leuven: Master of Engineering: Energy	
5	UPC BarcelonaTech	Grenoble INP-UGA	UPC: Master of Energy Engineering Grenoble INP-UGA: International Master of Science in Electrical Engineering for Smart Grids and Buildings	French national rule applies: full 60 Y1 ECTS required before Y2 enrolment.
6	UPC BarcelonaTech	KTH Royal Institute of Technology	UPC: Master of Energy Engineering KTH: Master of Science (120 credits)	
7	Grenoble INP-UGA	KU Leuven	Grenoble INP-UGA: International Master of Science in Electrical Engineering for Smart Grids and Buildings	

			KU Leuven: Master of Engineering: Energy	
8	Grenoble INP-UGA	UPC BarcelonaTech	Grenoble INP-UGA: International Master of Science in Electrical Engineering for Smart Grids and Buildings UPC: Master of Energy Engineering	
9	Grenoble INP-UGA	KTH Royal Institute of Technology	Grenoble INP-UGA: International Master of Science in Electrical Engineering for Smart Grids and Buildings KTH: Master of Science (120 credits)	
10	KTH Royal Institute of Technology	KU Leuven	KTH: Master of Science (120 credits) KU Leuven: Master of Engineering: Energy	
11	KTH Royal Institute of Technology	UPC BarcelonaTech	KTH: Master of Science (120 credits) UPC: Master of Energy Engineering	
12	KTH Royal Institute of Technology	Grenoble INP-UGA	KTH: Master of Science (120 credits) Grenoble INP-UGA: International Master of Science in Electrical Engineering for Smart Grids and Buildings	French national rule applies: full 60 Y1 ECTS required before Y2 enrolment.

Notes to the matrix

- All twelve pathways total 120 ECTS across Year 1 (60 ECTS) and Year 2 (60 ECTS), including the 30 ECTS Master's Thesis carried out at the Year 2 host university.
- Across all pathways, students additionally follow the ESADE-led Innovation & Entrepreneurship journey, for which they receive a certificate equivalent to 10 ECTS of learning activity from ESADE (Section 4.3).
- The official degree titles registered by each partner university under its national accreditation framework are listed below.
    - **KU Leuven (Belgium):** Master in de ingenieurswetenschappen: Energie (Master Energie) / Master of Engineering: Energy
    - **KTH Royal Institute of Technology (Sweden):** Teknologie masterexamen / Master of Science (120 credits)

- **Grenoble INP-UGA (France):** Master International “Réseaux et bâtiments intelligents – Gestion et efficacité énergétique” / International Master of Science in Electrical Engineering for Smart Grids and Buildings
- **UPC BarcelonaTech (Spain):** Master universitario en Ingeniería de la Energía / Master of Energy Engineering

Appendix C: Master's in Advanced Energy Systems & AI Admission Requirements

Admission to the Advanced Energy Systems & AI Double Degree Master requires a bachelor's degree in engineering or a closely related STEM field with solid foundations in mathematics, programming, and energy engineering. These competencies are essential for engaging with the programme's integrated curriculum in advanced energy systems, digitalisation, and artificial intelligence. Applicants should have prior knowledge of electrical circuits, energy conversion, thermodynamics, and numerical methods, and are recommended to have basic familiarity with data analysis or machine learning. Strong English skills and academic performance are required, and conditional admission may be granted to motivated applicants who complete bridging modules.

C.1 Eligible Bachelor's Degrees

Applicants must hold a bachelor's degree (180–240 ECTS) in a STEM or engineering discipline that provides the analytical and technical foundations required for advanced studies in energy systems, digitalisation, and AI.

Typical eligible fields:

- Electrical Engineering
- Energy or Power Engineering
- Mechanical or Electromechanical Engineering
- Sustainable Energy Systems
- Automation and Control Engineering
- Computer Engineering (with relevant energy coursework)

Other STEM degrees (Physics, Applied Mathematics, Computer Science, Industrial Engineering, Environmental Engineering) may be accepted if the applicant can demonstrate sufficient background in mathematics, programming, and energy-related coursework.

C.2 Required Prior Knowledge

To ensure readiness for the integrated curriculum combining energy technologies, digital approaches, AI, and systems innovation, applicants must demonstrate the following entry-level competencies:

A. Mathematics

Competence equivalent to at least 30 ECTS, covering:

- Calculus
- Linear algebra
- Differential equations
- Probability and statistics

B. Programming Skills

Ability to program in at least one language such as **Python**, **MATLAB**, or **C/C++**, including:

- Writing basic scripts
- Handling datasets
- Implementing numerical methods

This prepares students for hands-on work in:

- Machine learning
- Data-driven energy applications
- Digital simulation tools
- Optimisation and forecasting

C. Energy Engineering Foundations

Prior exposure to:

- Electrical circuits and systems
- Energy conversion principles
- Basic power engineering (e.g., power flows, grid components)
- Thermodynamics and heat transfer
- Renewable energy fundamentals

This background is necessary for courses such as:

- Power systems
- Power electronics
- Heating/cooling systems
- Renewable and sustainable energy technologies
- Energy markets and economics

D. Introductory Data Science / AI (recommended)

While not mandatory, familiarity with:

- Data analysis
- Basic machine learning concepts
- Numerical data processing

  is strongly recommended given the programme's integrated AI-and-energy orientation and early AI-focused elective options.

C.3 Academic Performance

Applicants must demonstrate the ability to succeed in a highly quantitative and interdisciplinary master programme. A strong overall academic record — especially in mathematics, engineering fundamentals, and computational subjects — is required.

C.4 Bridging and Conditional Admission

Applicants missing specific prerequisites may be offered **conditional admission**, requiring completion of bridging or preparatory modules in areas such as:

- Introductory machine learning
- Thermodynamics or heat transfer
- Electrical circuits or basic power engineering

This supports inclusion while ensuring academic readiness.

C.5 Language Requirements

All applicants must prove their proficiency in English. At InnoEnergy level, the requirements can be found at InnoEnergy Masters+ website (https://mastersplus.innoenergy.com/application-process/requirements/). At university level, there may be more specific language requirements.

Appendix D: Master's in Advanced Energy Systems & AI EIT Overarching Learning Outcomes

D.1 Competent in one or more scientific disciplines

- The graduate has active, advanced knowledge and insight into energy conversion and rational use of energy in several of the following areas:
  - Electrical energy (e.g., the generation from different primary sources of energy, transmission and distribution, control and regulation, efficient use)
  - Thermo-mechanical energy (e.g., the use of primary sources, conversion to other vectors, combustion, engines, and turbines)
  - Economic and regulatory aspects of energy (e.g., markets, regulations, the organisation in the European context)
  - Data-driven aspects of energy systems (e.g., the use of AI in modelling energy systems and flows at various scales, interactions with weather, humans and markets etc.,).
- The graduate actively looks for structure, and coherence between the integration of the relevant fields in these different domains.
- Based on this knowledge and its integration, the graduate can participate in state-of-the-art design, management, and production activities related to energy converters and systems in their economic, regulatory, and environmental context.
- The graduate possesses the skills and the attitude to apply, expand and formalise this knowledge in the context of more advanced ideas or applications in at least one of the three energy domains combined with data-driven elements, independently and efficiently.
- The graduate can identify techno-economic opportunities arising from emerging energy technologies and data driven methods, and evaluate the commercial, societal and sustainability value of potential solutions.

D.2 Competent in Data-Driven and AI-Supported Energy Systems Analysis

- The graduate has advanced and critical knowledge of artificial intelligence and machine learning methods relevant to the modelling, analysis, and optimisation of complex energy systems.
- The graduate is capable of collecting, structuring, and managing large and heterogeneous datasets related to energy systems, and of making informed choices regarding data quality, representation, and appropriate levels of abstraction across operational, environmental, market, and socioeconomic data sources.
- Based on this foundation, the graduate can design, develop, and critically evaluate data-driven and hybrid AI–physics models for forecasting, optimisation, and decision support in energy systems, integrating artificial intelligence techniques with domain knowledge in electricity systems, thermomechanical systems, and energy markets.
- The graduate is able to assess the reliability, robustness, and limitations of AI-based approaches, including issues of uncertainty, interpretability, scalability, and transferability, and to reflect on their suitability for real-world energy system applications.
- In doing so, the graduate demonstrates an understanding of the ethical, societal, and governance implications of artificial intelligence in the energy sector and is able to translate data-driven insights into responsible and actionable strategies that support the sustainable transition of energy systems.
- Based on analytical insight, the graduate can recognise market or operational niches where AI-enabled solutions create added value, and can articulate the feasibility, risks, and stakeholder value of such innovations.

D.3 Competent in conducting research

- The graduate is capable of structuring realistic problems (of a more complex nature) as a research question, designing a research plan, developing innovative solutions, and synthesising while considering the limits of the system.
- The graduate can choose the appropriate level of abstraction on a component, device, and system level, given the process stage of the research problem.

- The graduate is capable of and has the attitude to integrate related energy systems and other disciplines where needed in their own research.
- The graduate is able to frame research questions in ways that consider industrial relevance, innovation potential, and pathways to real-world application or venture creation.

D.4 Competent in designing

- The graduate is able to design energy components and systems with an eye for the dynamic interaction between individual components in a global system.
- The graduate is able to deal with the changeability of the designing process due to external circumstances, such as social tendencies or political decisions, or advancing insight. They can adjust this process based on these circumstances, and effectively manage risks while dealing with limited resources to be able to work purposefully, with a pragmatic approach.
- The graduate can integrate user needs, market constraints, and techno-economic viability into design choices, supporting translation from concept to deployable product or service.
- The graduate can coordinate design processes involving multiple actors, balancing technical, economic, regulatory, and societal considerations to make informed, responsible design decisions.

D.5 Scientific approach

- The graduate is able to critically regard existing theories, models, or interpretations in the field of energy.
- The graduate is able to use, develop and validate models and experimental techniques and is able to make an informed choice between modelling and measuring methods. In this context, they are able to critically reflect on their own thoughts, decisions, and actions.
- The graduate possesses the skills and knows the techniques to become more proficient in their technical field. They know the sources of information, recognise their value, and know how to apply them in new circumstances. The graduate possesses the ability to continue developing their skills with respect to non-technical elements of the field of energy, such as economic, environmental, and regulatory aspects.

D.6 Basic intellectual skills

- The graduate is able to ask pertinent questions regarding an argument in the field of energy and take a reasoned position. They hereby consider social context.
- The graduate is able to apply methods of reasoning to the discipline (e.g., interactions between components of the electricity system as a basis for stability, energy and pinch analysis in thermodynamics, market forces, and integration of renewable sources of energy) and is able to recognise and refute fallacies.

D.7 Competent in collaboration and communication

- The graduate is able to effectively report on research and project results to experts, peers, and stakeholders, in English, both orally and in writing.
- The graduate can lead multidisciplinary teams, facilitate decision-making processes, and support collective problem solving in complex energy AI contexts.
- The graduate can adapt communication styles to motivate, coordinate, and align diverse stakeholders, including industry, policymakers, and communities.

D.8 Taking the temporal and social context into account

- The graduate considers the (changing) social context, such as societal support, policy decisions, the socio-economic context, geopolitics, energy markets, and climate change, when analysing and solving complex energy problems.
- The graduate considers the existing and future challenges of power supply and can contribute to the transition of the energy system in a globalised society, from a technical and socio-economic perspective.
- The graduate can take leadership in navigating socio-technical transitions, guiding teams or organisations in evaluating long-term consequences, assessing risks, and steering energy system innovations responsibly.
- The graduate is aware of Sustainable Development and Corporate Social Responsibility frameworks for organisations working in the energy sector. They know how to seek out and understand the specific policies of any employer or research institution they join, and are able to apply these

principles when making professional decisions, raising concerns, or evaluating the consequences of their own work.

Appendix E: Bridging and Harmonisation courses for Master's in Advanced Energy Systems and AI

The AESAI programme combines energy systems engineering with data science and AI, and admits students from a range of engineering and STEM backgrounds. Some students will therefore need to refresh individual prerequisites before or during the programme.

This appendix describes the bridging and harmonisation resources available to AESAI students who need to consolidate specific prerequisites, whether on admission or during the programme. Two groups are described: InnoEnergy online courses, which are available to enrolled students through the joint learning platform, and selected external open courses, which are grouped by subject matter and, within each subject, by learning platform.

E.1 InnoEnergy courses

Enrolled AESAI students have access to the InnoEnergy online professional learning courses through the joint learning platform. The catalogue ranges from introductory to advanced level and is not restricted to purely technical content. Access instructions are issued to students separately by InnoEnergy.

InnoEnergy Electricity

- Electricity market https://learn.mastersplus.innoenergy.com/learn/courses/492/electricity-markets
- Energy Systems Integration: Evolution in Electricity Grids https://learn.mastersplus.innoenergy.com/learn/courses/583/energy-systems-integration-evolution-in-electricity-grids
- Energy System Transformation https://learn.mastersplus.innoenergy.com/learn/courses/496/energy-system-transformation/lessons

InnoEnergy AI/Data science

- Managing Energy Data https://learn.mastersplus.innoenergy.com/learn/courses/856/managing-energy-data
- MSc Energy for Smart Cities - Machine Learning for Energy students https://learn.mastersplus.innoenergy.com/learn/courses/56/msc-energy-for-smart-cities-machine-learning-for-energy-students
- Cybersecurity in the Energy sector https://learn.mastersplus.innoenergy.com/learn/courses/584/cybersecurity-in-the-energy-sector
- Blockchain in the energy sector https://learn.mastersplus.innoenergy.com/learn/courses/619/blockchain-in-the-energy-sector

Open book Designing Renewable Energy Systems within Planetary Boundaries (2025)

Designing Renewable Energy Systems within Planetary Boundaries (written by InnoEnergy Professor Mika Jarvinen and Hanna Paulomaki) is a comprehensive, interdisciplinary textbook that addresses the technical, ecological, and social dimensions of the energy transition. This book is an excellent resource for InnoEnergy Masters+ students and faculty. It not only delivers the technical knowledge required for designing and optimising renewable energy systems, but also cultivates the critical, interdisciplinary mindset needed to lead the energy transition within planetary boundaries. Its case studies, exercises, and open-access format further enhance its value for teaching, group work, and self-study across all InnoEnergy programmes. Free download here: https://link.springer.com/book/10.1007/978-3-031-69856-9.

The book covers renewable generation, energy storage, and power systems alongside the ecological and social dimensions of the energy transition, and is suitable for self-study across the AESAI energy components.

- **Systems Thinking & Interdisciplinarity:** The book goes beyond traditional techno-economic analysis, embedding energy engineering within ecological and social contexts.
- **Planetary Boundaries & Sustainability:** Early chapters introduce the planetary boundaries framework, biodiversity, and the concept of strong sustainability.
- **Technical Depth Across Technologies:** The book covers the full spectrum of renewable energy systems—solar, wind, bioenergy, energy

storage, power systems, and more—with up-to-date technical detail, practical examples, and real-world case studies.

E.2 External courses

The InnoEnergy courses listed above are available to enrolled students at no cost. The external courses below are open courses offered by third-party providers and are suggested as optional means of refreshing prerequisite knowledge. They are grouped by subject matter and, within each subject, by learning platform.

Access and fees

Access conditions vary by provider. The courses listed have been selected because their content can generally be accessed at no cost. Certification, where offered, is charged separately by the provider and is not funded by the programme.

Access via Coursera

On Coursera, the "enrol for free" route grants a seven-day trial; course content can instead be accessed without charge through the "audit the course" option, which is offered for most, though not all, of the courses listed. Where auditing is unavailable, the provider offers a limited preview.

The courses below are grouped by subject and cover the energy-side prerequisites set out in Appendix C.4 — electrical circuits and power engineering, thermodynamics, and electronics — together with photovoltaics as a related specialisation topic. The list is indicative: conditionally admitted students agree with their host university which courses to complete, and other students may use it to refresh individual topics.

Electricity

Coursera Electricity

- Electric Power Systems https://www.coursera.org/learn/electric-power-systems

Thermodynamics

Coursera Thermodynamics

- Introduction to Thermodynamics: Transferring Energy from Here to There https://www.coursera.org/learn/thermodynamics-intro

Electronics

Coursera Electronics

- Introduction to Power Electronics https://www.coursera.org/learn/power-electronics
- Converter Circuits https://www.coursera.org/learn/converter-circuits
- Converter Control https://www.coursera.org/learn/converter-control

PV-related courses

TU Delft has a large offer, all on EdX. They are offered as “micromaster” which allows students to apply for the regular TU Delft master programmes, but the courses themselves are classified at bachelor-level:

- Solar Energy: photovoltaic (PV) systems: https://www.edx.org/learn/solar-energy/delft-university-of-technology-solar-energy-photovoltaic-pv-systems
- PV energy conversion: https://www.edx.org/learn/solar-energy/delft-university-of-technology-solar-energy-photovoltaic-pv-energy-conversion
- Integration of PV systems in microgrids: https://www.edx.org/learn/solar-energy/delft-university-of-technology-solar-energy-integration-of-photovoltaic-systems-in-microgrids