RES4CITY

renewable energies system for cities

Deliverable D2.3

A multidisciplinary micro-credential basket for the sustainable transition in cities

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DISCLAIMER

EXECUTIVE SUMMARY

RES4CITY is committed to cultivating a skilled workforce by promoting sustainability and circularity in the field of renewable energy and fuel technologies, specifically in urban contexts. This mission is achieved through a pioneering educational initiative developed in collaboration with stakeholders. This forward-thinking educational program serves as a platform for individuals to develop specialized skills and knowledge, aligning with the European Union's overarching goal of enhancing digital literacy and lifelong learning, in line with the Bologna process. Amidst the evolution of Europe's educational structure, micro-credentials are gaining traction as a student-centred approach to lifelong learning. Generally, micro-credentials are short, focused, and specialized educational programs that provide learners with the opportunity to acquire and demonstrate specific skills and knowledge that are in demand in the workforce. The main pillars of the European approach to micro-credentials can be summarised as follows:

- Micro-credentials must be **measurable, comparable, and understandable learning units**, with clear learning outcomes, workload, content, level and learning offer.
- They must be **modular** to allow the possibility of stacking, validating and recognising their learning outcomes across different systems.
- Their design must be carried out with a **meet-the-needs approach**.
- **Micro-credentials are owned by the learner** and may be stored and shared safely through secure digital wallets.

Starting from its alignment with the ongoing transformation of the European educational framework under the Bologna process, RES4CITY's educational programs primarily focus on renewable energy and sustainable fuel technologies, with a specific emphasis on creating strategies tailored to urban settings. RES4CITY has assembled a curated selection of diverse multidisciplinary micro-credentials, co-designed with relevant stakeholders. This collection forms the basis of an MCs basket designed to cater to a broad spectrum of learners, including students and professionals, regardless of their STEM or non-STEM background. The main features of RES4CITY approach to micro-credentials are summarised as follows:

Target audience: RES4CITY educational programmes targets two types of audience:

- Students enrolled in accredited university courses at EQF (European Qualification Framework) 6-7-8, corresponding to a Bachelor, Master and PhD courses, in both STEM and NON-STEM disciplines (section 2.2)
- Young professionals working both in energy and non-energy related areas with both STEM and NON-STEM background.

Need assessment and competence definition: RES4CITY implemented a co-design process by leveraging on the Innovation and Stakeholder network. The identified educational needs were translated into specific learning units which forms the MCs. A hierarchical framework for categorizing educational goals based on the Bloom’s taxonomy was used to guide the development of learning objectives and to ensure that the learning objectives span across different levels to promote a comprehensive understanding and application of the subject.

Micro-credential learning units: each MC in the RES4CITY basket was sized according to the European Credit Transfer and Accumulation System (ECTS), adopted by the EHEA, to support the transparency and stackability of the obtained credentials. A size of 2.5 ECTS for each MCs was selected since it allows (i) to correctly define the learning outcomes of each MC, (ii) to ensure a successful delivery of the MC

content, (iii) to organise each MC in week-based subunits with an average student effort (total) between 12-18 hours per subunit and a total duration between 4-6 weeks.

Subject classification: RES4CITY adopted the ISCED-F (International Standard Classification of Education – Fields of education and training) as a reference to classify and organise the micro-credential basket based on its fields of education. The following ISCED-F codes were used to classify RES4CITY micro-credentials:

- 031: Social and behavioural science (including economic and finance)
- 041: Business and administration
- 052: Environmental science
- 061: Information and communication technologies (including data science)
- 071: Engineering and engineering trades
- 072: Manufacturing and material
- 073: Architecture and construction

Referencing to the detailed description of the education fields, the ISCED-F codes were selected and used to indicate the main discipline (i.e., primary discipline) of each MC. It is important to highlight that due to the intrinsic multidisciplinary of RES4CITY's learning programmes, most of the MCs can be related to multiple disciplines. Consequently, secondary ISCED-F codes were assigned to each MC where relevant (i.e., complementary disciplines).

RES4CITY MICRO-CREDENTIAL BASKET: in accordance with the specification outlined above, RES4CITY developed a basket of 74 micro-credentials (Annex A). This document provides an overview of the RES4CITY micro-credential basket, detailing the methodology used to identify learning objectives, define MC content and learning approaches, specify target audiences, and encompass covered subjects. The following table summarises the main features of the RES4CITY micro-credential basket.

RES4CITY MCs basket overview							
MCs number	74						
Single MC size	2.5 ECTS						
Average time to MC completion	4-6 weeks						
Average student's effort (estimated)	12-18 hours / week						
Target groups	**STEM oriented**		**NON-STEM oriented**		**Both STEM/NON-STEM**		
MCs number	27		15		32		
EQF levels	**EQF 6**		**EQF 7**		**EQF 8**		
MC numbers	45		55		39		
Disciplines (ISCED-F codes)	**031**	**041**	**052**	**061**	**071**	**072**	**073**
Primary	8%	30%	5%	3%	41%	9%	4%
Complementary	15%	16%	14%	14%	19%	10%	12%

RES4CITY KPIs			
KPI	**Description**	**Target**	**MCs**
-	Number of micro-credentials identified	55	74
1	Focussed on social and environmental aspects (air pollution, waste management, job opportunities, wildlife concerns, etc.) of RES and RFT.	15	19
5	Co-designed for the development of training and reskilling opportunities in RES and RFT	18	19
11	Focussed on the Circular Economy Action Plan, Critical Raw Material, recycling by design	21	26

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List of Acronyms

Acronym	Meaning
ECTS	European Credit Transfer and Accumulation system
EHEA	European Higher Education Area
EQF	European qualification framework
HE	Higher education
ISCED	International Standard Classification of Education – Fields of education and training
MC	Micro-credential
SDG	Sustainable development goals
STEM	Science technology engineering and mathematics
UN	United Nations
VET	Vocational education and training

1. INTRODUCTION

1.1 Bologna process

The Bologna process, signed in 1999 in Bologna by the Ministries of Education from 29 countries, established the European Higher Education Area (EHEA) aiming at:

- Harmonising the higher education framework through the introduction of a three-cycle system (i.e., bachelor, master and doctoral studies).
- Introducing the European Credit Transfer and Accumulation system (ECTS), which allows students to acquire credits based on defined learning outcomes and transfer them between recognised academic institutions.
- Enhancing the mobility of students and educators, while ensuring the mutual recognition of qualifications and learning periods abroad.
- Developing and implementing a quality assurance system for teaching and learning.

Since then, the EHEA has provided a framework and practical guidelines and tools for the definition of learning outcomes, qualification framework, monitoring and evaluation procedures, diploma supplement, etc. – which supported the modernisation and improvement of the quality of higher education (HE) provision. The envisioned harmonisation has led to a greater compatibility and comparability of the European HE system, which represents a fundamental driver for enhancing attractiveness, competitiveness and employability of graduates [1].

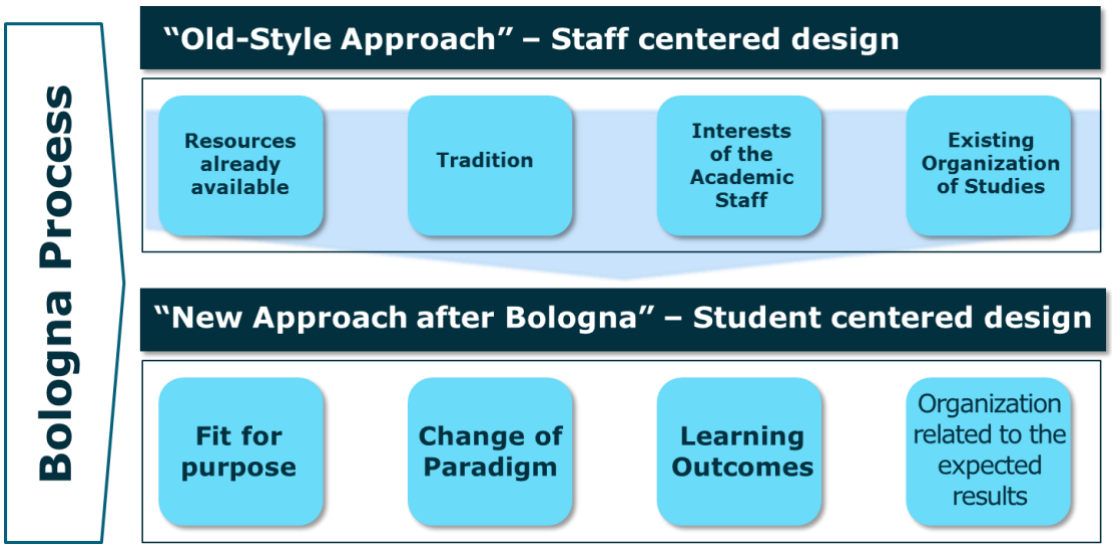

Figure 1: Main changes introduced by Bologna Process

One of the main innovations fostered by the Bologna process is the paradigm change for the course design process from a "*staff-centred*" to a "*student-centred*" approach (Figure 1). This simple statement implies a change of mindset of academicians in the design of study courses and a re-organization of teaching activities at academic institutions. By implementing a "student-centred" approach, the design of course programmes (from the definition of the learning outcomes to the introduction of innovative, transversal and job-oriented skills) must be performed in relation to the students' needs rather than the interests of the academic staff and the specific constraints in terms of resources available at the academic institution.

- Switching to a student-centred approach has many implications on the way academic curricula are designed, implemented and monitored.

- First, a continuous interaction between academic institutions and external stakeholders is required since the design stage of the programme in order (i) to tailor the program learning objectives on the specific skills required to meet the students' needs and boost the graduates' employability, (ii) to monitor and verify the learning outcomes acquired by the graduates, (iii) to update the programme learning objectives and contents in response to a change of students' needs and job market.
- Curriculum reforms need to be fostered to ensure high-quality, flexible and more individually tailored education paths on the student specific needs and interests [2]. Important tools aimed at enhancing these aspects are represented by the ECTS and qualification frameworks, which supports the mutual recognition of competences, as well as students' mobility programmes, established under the EHEA. However, student-centred learning also requires the deployment of effective support and guidance structures to empower individual learners in defining their education path, while supporting them in exploring learning and professional opportunities.
- Furthermore, a student-centred approach requires a supportive and inspiring learning environment built upon innovative teaching and learning methods, updated course contents and high-quality teaching at all levels.

Student-centred learning gained political recognition in the Bologna Process agreement in 2009 through the Leuven /Louvain-la-Neuve Ministerial Communiqué, which reasserted "*the necessity for a curricular reform geared toward the development of learning outcomes*" and envisioned this curricular reform as "*an ongoing process leading to high quality, flexible and more individually tailored education paths*" [3]. These statements were reiterated in 2012 by the Bucharest Ministerial Communiqué [4] and the European Commission's Communication on Rethinking education [5], which led to the establishment of a specific agenda of the Bologna Follow-Up Group. Since then, student-centred learning has been one of the main focuses of the EHEA framework, which expanded its definition by including new aspects such as, the role of digital technologies (Yerevan Communiqué, 2015 [6]), open education in the context of lifelong learning (Paris Communiqué, 2018 [7]) and the introduction of smaller and flexible units, i.e., micro-credentials (Rome Communiqué, 2020 [8]). Table 1 outlined the main political innovation introduced by the EHEA Ministerial Conferences over the last decades.

The envision shift towards student-centred education is recognised to be a fundamental pillar to support the lifelong learning policy established by the EHEA as a needed strategy to face the challenges posed by job-market turmoil and new digital technologies on social cohesion, equal opportunities and quality of life. Therefore, lifelong learning has been put at the centre of the Bologna Process agenda and a dedicated working group on social dimension and lifelong learning have been established under the EHEA. Pillars for an effective development of lifelong learning can be summarised as follows:

- Widening access to higher education.
- Creating more-flexible, student-centred modes of delivery.
- Improving the recognition of prior learning, including non-formal and informal learning.
- Developing national qualification frameworks.
- Improving cooperation with employers, especially in the development of educational programmes.

Table 1: Summary of the political innovation following the EHEA Ministerial Conferences over the last decades

EHEA Ministerial conference	Year	Main political innovations
London	2007	• Compatibility and comparability of national educational systems • Foster staff mobility, students and graduates. • Strategies and policies supporting the social dimension. • Common data collection framework. • Student-centred and outcome-based learning support.
Leuven/Louvain-la-Neuve	2009	• Quality assurance monitoring. • Diversity, equal access and opportunities. • Lifelong learning. • Student-centred learning enhancement • Employability. • Synergies with research and innovation.
Bucharest	2012	• Joint programmes and degrees. • Access widening for underrepresented groups. • Problem-solving and entrepreneurial skills. • Mobility for better learning.
Yerevan	2015	• Digital technologies for learning and teaching. • Flexible learning paths. • Involvement of students as stakeholders. • International mobility for study and placement. • Permeability between education sectors.
Paris	2018	• Open education for lifelong learning. • Interdisciplinary programmes. • Digital and blended education. • Transnational cooperation in HE, research and innovation. • Synergies with the UN SDGs.
Rome	2020	• Knowledge circulation and outreach principle. • Students' rights. • Learning offer diversification. • Introduction of small and flexible units of learning (micro-credentials). • Development of digital skills and competence for all. • Curricula internationalisation. • Secure, efficient and transparent exchange of data.

In the context of the transformation of the European educational framework, the use of micro-credentials as long-life learning and student-centred educational strategy is attracting a lot of interest. Generally, micro-credentials are short, focused, and specialized educational programs that provide learners with the opportunity to acquire and demonstrate specific skills and knowledge that are in demand in the workforce. They are designed to be flexible and provide learners with the ability to pursue their education and career goals and, consequently they are usually shorter than traditional degree programs and focus on providing learners with specific skills and knowledge tailored on their needs.

Micro-credentials may serve as an add-on to the existing provision of continuing education and training and mobility schemes, driving an innovation agenda in higher education, as MOOC have previously done by enabling the development and provision of short courses of applied learning to learners through flexible online courses. The development and implementation of micro-credentials

is shaped by the strategies and vision of higher education institutions on the one hand, and the involvement and dedication of forward-thinking professionals on the other hand. The success of micro-credentials depends on the collaboration and interaction between these two groups and society at large. To achieve this, a combination of top-down and bottom-up strategies are usually used. Higher education institutions often stress the importance of forming strong partnerships to gain a better understanding of the needs and dynamics of the workforce, as the relevance of micro-credentials is crucial for a sustainable approach.

1.2 The European micro-credentials framework

The European Skills Agenda recognises micro-credential as a promising tool to empowering professionals for tailored and accessible skills (re)development. To create a European approach to micro-credentials which can strengthen the societal mission of education institutions and can be applied to all education sectors, the European commission has recently issued a policy document [9] to establish a common definition of micro-credentials, to standardise their main elements and provide guidelines on how to design, monitor and assess the learning outcomes (Figure 1).

A micro-credential is the **record of the learning outcomes** that a learner has acquired following a small volume of learning.	
Learning outcomes	Provide with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs.
Quality assurance	Assessment against transparent and clearly defined standards in the relevant sector or area of activity
Ownership and portability	Micro-credentials are owned by the learner, can be shared and are portable
Stackability	They may be standalone or combined into larger credentials

Figure 2: Definition and main characteristics of micro-credentials according to [9]

Ten universal principles, applicable to all sectors or area, have been identified as guidelines on how to design, develop and issue micro-credentials which represent the key characteristic of the European approach [9]. These principles, which are the foundation of the RES4CITY approach as detailed in section 1.3, are listed in Table 2 and summarised in Figure 3.

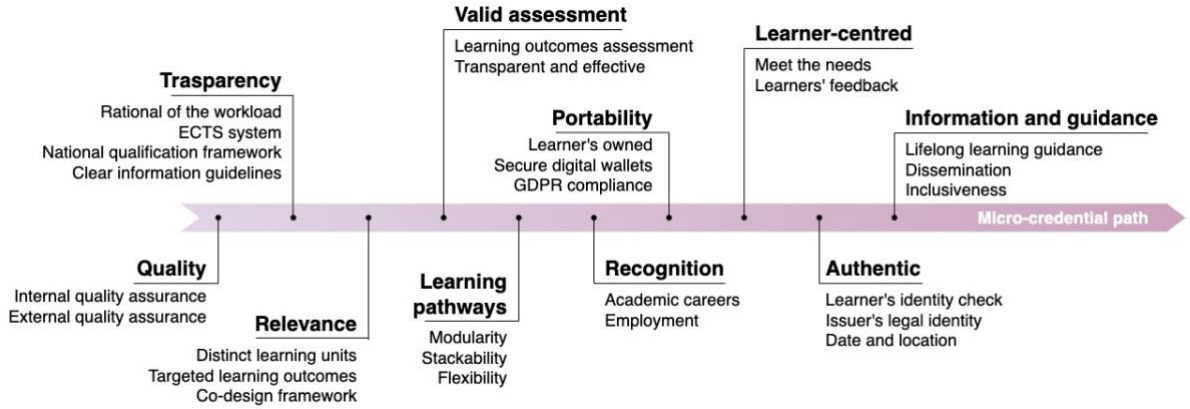

Figure 3: The European approach to micro-credentials

Table 2: The ten principles defined by the European approach to micro-credentials.

PRINCIPLE 1	QUALITY

Micro-credentials must be subjected to internal and external quality assurance. The quality assurance process must be fit-for-purpose, clearly documented, accessible and it must meet the needs of learners and stakeholders. Two types of quality assurance processes are envisioned:

- Internal quality assurance: ensured by the micro-credential courses providers, for each micro-credential the internal quality assurance must assess:
  - Quality of the micro-credential, based on clear and common standards related to the specific sector or area.
  - Quality of the course leading to the learning objectives of the micro-credentials, in terms of course structure, contents, teaching materials etc.
  - Learners' feedback on their learning experience.
  - Peers' feedback, including stakeholders and other providers.
- External quality assurance: it must be based on assessing the providers, with a specifical focus on their internal quality assurance process. The following guidelines and recommendations may be adopted, where relevant:
  - Annex VI of the European Qualification Framework.
  - Standards and Guidelines for Quality Assurance in the EHEA.
  - EQAVET (European Quality Assurance Reference Framework) for vocational education and training (VET).

  The use of external quality assurance instruments and certification from recognised agencies is suggested to build up trust in micro-credential.

  HEI micro-credential providers should be included in the Database of External Quality Assurance Results (DEQAR), in line with the Standards and Guidelines for Quality Assurance In the EHEA.

PRINCIPLE 2	TRASPARENCY

Micro-credentials are measurable, comparable and understandable learning units, with clear information on learning outcomes, workload, content, level and learning offer.

- Workload: the use of ECTS (European Credit Transfer Accumulation System) should be used by HEI. Other providers may use other measurable systems, which however must be functional in describing the learning outcomes of the micro-credentials. In general, the rational of the workload required to reach the learning objectives of the micro-credential needs to be demonstrated, in line with the Annex V of the EQF Recommendation.
- Qualification system: micro-credential should be recognised within the national qualification framework, where relevant and in line with national priorities and policies, to further support transparency and trust.
- Information guidelines: clear, effective and transparent information on micro-credential offers and micro-credential systems must be established to provide guidance to learners and stakeholders. This also includes information on providers, which should be published in open registers, and information on learning opportunities, which should be accessible and easily exchanged through relevant platforms (e.g., Europass).

PRINCIPLE 3	RELEVANCE

Micro-credentials should be shaped as distinct learning units, with targeted learning outcomes and in response to specific learning needs and opportunities. This allows them to be updated as required to reflect changes in learning needs raising from modified job-market contexts, sector or scientific innovation, etc. Achieving this goal requires a close cooperation between micro-credentials providers and relevant stakeholders, including learners, to boost the relevance of the micro-credentials for the job-market. Moreover, relevance implies also that micro-credentials can meet the current and future needs of the learners.

Relevance can be established by involving industry and employer representatives in the development of the micro-credential program, by conducting market research to identify the skills and knowledge that are in demand, and by regularly reviewing and updating the program to reflect changes in industry standards and employer needs.

PRINCIPLE 4	VALID ASSESSMENT

Micro-credential learning outcomes must be assessed against standards, which should possess the following characteristics:

- Alignment with the learning outcomes of the program.
- Adoption of assessment methods that are appropriate for the skills and knowledge being assessed.
- Fair and unbiased design and administration of the assessment process.
- Provide an accurate and reliable measure of the learners' skills and knowledge.
- Provide valid and reliable feedback for learners and instructors.
- Be authentic, relevant, reliable and transparent about the criteria used to evaluate and grade the assessments.
- Provide an opportunity for learners to demonstrate their knowledge and skills in a real-world setting.

PRINCIPLE 5	LEARNING PATHWAYS

Micro-credentials must be designed as modular learning units to allow the possibility of stacking, validating and recognising their learning outcomes across different systems. This is functional for supporting the creation of flexible learning pathways envisioned by the Bologna Process.

- **Stackability**: the modular nature of micro-credentials allows learners to combine or combine them to create larger credentials. Micro-credential providers should have clear procedures in place for evaluating requests of merging or combining micro-credentials from learners, with transparent regulations outlining opportunities and limitations.
- **Informal learning**: under the EC recommendation, micro-credentials could also be obtained by the assessment of the learning outcomes obtained by learners resulting from informal learning.

PRINCIPLE 6	RECOGNITION

Micro-credentials can be recognised in the framework of academic careers and for employment purposes. Standard recognition procedures - such as the ones used by HEI in recognising foreign qualification and learning periods abroad – could be used. The mutual recognition of micro-credential learning outcomes represents a fundamental milestone for the development of a comparable scheme for micro-credentials across the EU. Mutual recognition of micro-credentials can be achieved by making micro-credentials compatible with the existing academic or professional recognition systems, such as academic credit, professional certifications, or continuing education units.

PRINCIPLE 7	PORTABILITY

Generally, portability of micro-credentials means that the credit or recognition earned through the program can be easily transferred to other institutions or employers, allowing learners to continue their education or advance their careers. This can be achieved by aligning the micro-credential program with industry standards and employer needs, and by ensuring that the program is recognised by other institutions and employers. To ensure portability, institutions should establish clear and consistent standards for the micro-credential program and provide clear and accessible information about the micro-credential program, including the learning outcomes, assessment methods, and recognition process. Micro-credentials are owned by the learner (i.e., credential holder) and may be stored and shared safely through secure digital wallets (e.g. Europass). Institutions offering micro-credentials must comply with the GDPR regulations when collecting, storing, and using personal data of learners enrolled in their programs. This includes obtaining consent from learners for the collection and use of their personal data, providing learners with access to their personal data and the ability to request that their personal data be corrected or deleted, and implementing appropriate security measures to protect the personal data of learners.

PRINCIPLE 8	LEARNER-CENTRED

The design of micro-credentials should be carried out considering the needs of the learners' target group. To ensure that the program meets the needs of the learners, it is important to involve the target group of learners in the design process. Including learners as stakeholders in the design process ensures that their perspectives, needs, and preferences are considered. Furthermore, involving learners in the quality assurance process is also important. Quality assurance is the process of ensuring that the micro-credential program meets established standards and that the learning outcomes are being achieved. Learners' feedback can be

used as a measure of the program's effectiveness and can be used to make improvements to the program. Furthermore, involving learners in the design and quality assurance process not only helps to improve the micro-credential program but also increases the learners' engagement and motivation, and can increase the chances of the learners to achieve their desired outcomes.	
PRINCIPLE 9	**AUTHENTIC**
Authenticity means that the micro-credential is issued by a reputable and accredited institution, and that the information provided about the learner, the institution, and the micro-credential is accurate and verifiable. This helps to ensure that the micro-credential is recognised and valued by employers and other institutions. To ensure authenticity, institutions should establish processes for collecting and verifying information about the learners, such as collecting official transcripts or other documentation, and for issuing the micro-credential, such as providing a unique identifier or digital signature. The micro-credential should also be stored in a secure and tamper-proof format, such as a digital badge, and include a verifiable record of the learner's identity, the institution that issued the micro-credential, and the date of issuance. Additionally, institutions should also have a process for verifying the authenticity of the micro-credential when it is presented by the learner to an employer or other institution. This may include providing a means for employers or other institutions to verify the micro-credential's authenticity by checking the institution's website or contacting the institution directly.	
PRINCIPLE 10	**INFORMATION AND GUIDANCE**
Lifelong learning guidance services incorporating information and advice on micro-credentials, should be established to reach the widest possible learning groups while considering inclusiveness and supporting education, training and career choice. These services should be established to reach the widest possible learning groups, including individuals from diverse backgrounds, ages, and experience levels. should provide learners with accurate, up-to-date information about the micro-credential program, including the learning outcomes, assessment methods, and recognition process. They should also provide guidance on how to choose the right micro-credential program for the learner's needs, and how to transfer the credit or recognition of the micro-credential to other institutions or employers.	

1.3 RES4CITY contribution to the European micro-credential framework

As outlined in section 1.2, the European Union Micro-Credential Framework aims at promoting the recognition and standardisation of micro-credentials within the EU as part of the EU's wider efforts to promote digital and lifelong learning and to support the development of a highly skilled and competitive workforce. In line with the EU framework objectives, RES4CITY aims to support the development of a highly skilled workforce by promoting sustainability and circularity in the development of renewables and fuel technologies in cities through an innovative educational program co-designed with stakeholders. The educational program offers individuals the chance to gain specific skills and knowledge, and the inclusion of micro-credentials aligns with the EU's broader aim of promoting digital and lifelong learning.

RES4CITY educational programmes focuses on renewable energy and sustainable fuel technologies and strategies for urban areas. Generally, promoting the use of renewable energy sources and sustainable fuel technologies aims to reduce greenhouse gas emissions and minimise the impact on the environment, thus supporting sustainable development. Cities are considered important targets for promoting renewable energy and sustainable fuel technologies since they are home to more than half of the world population while they account for about 75% of carbon emissions and between 60-80% of energy consumption. By 2050, about two-thirds of all humanity will live in urban settlements and, as outlined by the Sustainable Development Goals (SDG), sustainable development requires a radical transformation in the way we build and manage our urban spaces [10].

Furthermore, cities are often at the forefront of innovation, which makes them suitable as test beds for new technologies and approaches to energy use and sustainable development. Moreover, local

governments have the power to make local decisions about energy use and sustainability, and by acting, they can play a critical role in driving global progress towards a more sustainable future. Reducing greenhouse gas emissions and increasing energy efficiency using renewable energy and sustainable fuel technologies helps cities be better prepared for the impacts of climate change and increases their resilience. By relying on renewable energy sources such as solar, wind, and hydro, dependence on fossil fuels can be reduced, which enhances energy security while also creating new economic opportunities and jobs in the manufacturing, installation, and maintenance of renewable energy systems, leading to economic benefits. Moreover, clean energy technologies can also improve air quality, reduce noise pollution, and result in better health outcomes for urban residents, improving their quality of life.

Future sustainable and smart cities should foster the deep integration and control of multiple energy vectors leveraging the latest scientific research developments and technological advancements, while promoting the deployment of renewable energy sources and fuel technology substitution and to promote circularity between sectors. Such framework should address the challenge of fragmented methodologies by valorising the integration and synergies in a multisector and multidisciplinary perspective. In this context, education plays a fundamental role since it is crucial in understanding, explaining and addressing the challenges with whom the society confront; this is a fundamental pillar for the grow of human capital and for raising awareness among citizens. Secondly, the development of multidisciplinary skills and competence of professionals is paramount for bridging the gaps between sectors, unlocking circularity opportunities for rational efficient energy and material consumption in urban areas.

To achieve these goals, it is crucial to overcome several educational gaps which could jeopardise the uptake of sustainable renewable energy solutions in urban areas, such as the need for an interdisciplinary knowledge and competences, as for instance:

- Technical expertise: lack of technical expertise in the main design features of renewable energy systems and sustainable fuel technologies can pose a significant barrier to the widespread adoption of these technologies in cities. This is particularly relevant for policymakers and financial professionals with a non-STEM education background.
- Financial literacy: lack of financial and economic literacy can make it challenging for cities to understand the costs and benefits of different energy sources and technologies, and to make informed decisions about investment in renewable energy and sustainable fuel technologies. Furthermore, the gaps between technical and financial skills and competence may affect both stem and non-stem professional in the decision-making progress, with the risk of jeopardising the successful implementation and deployment of sustainable energy projects.
- Policy and regulation: there are often gaps in knowledge and understanding of policies and regulations related to energy use and sustainability, and the role they play in driving the sustainable transition in cities. Moreover, to be effective, policies and regulations must be implemented in a consistent and systematic manner, their effects must be closely monitored, to ensure that they are having the intended impact and for a continuous policy improvement. This requires multidisciplinary skills and competence ranging from technical, economic, financial and policy fields.
- Social and behavioural Sciences: it plays a critical role in promoting the sustainable transition in cities by understanding and addressing the behaviours, attitudes, and beliefs of individuals and communities. The factors that drive energy use and sustainability behaviours should be

considered to develop strategies to influence these behaviours and to capture the social acceptance of technologies and strategies.

In this context, RES4CITY has developed 8 micro-courses targeting both students and professionals with stem and non-stem background to foster multidisciplinary skill and competence acquisition. The programs are based on a selection of 44 micro-credentials from a basket of 74 MCs, which are co-designed in collaboration with relevant stakeholder and, therefore, are tailored to the identified educational needs. The present document describes the MC basket (74 MCs), outlining the methodology adopted for the identification of the learning objectives, definition of MC contents and learning methods, target groups and subjects covered.

2. THE RES4CITY APPROACH

2.1 Overview of the design framework

The learning objectives of a micro-credential typically focus on specific knowledge, skills, or competencies that learners are expected to acquire or demonstrate upon completion of the micro-credential. In the context of RES4CITY, a basket of micro-credentials was developed based on the step-by-step approach summarised in Table 3.

Table 3: RES4CITY approach to microcredentials

n.	Step	Description	RES4CITY approach
1	Target audience identification	Determine who the micro-credential is intended for, such as professionals in a particular industry, students pursuing a specific field of study, or individuals seeking to acquire new skills.	RES4CITY educational programmes targets two types of audience: • Students enrolled in accredited university courses at EQF 6-7-8, corresponding to a Bachelor, Master and PhD courses, in both STEM and NON-STEM disciplines (see section 2.2) • Young professionals working both in energy and non-energy related areas with both STEM and NON-STEM background.
2	Need assessment	Understand the needs and requirements of the target audience.	RES4CITY implemented a co-design process by leveraging on the Innovation and Stakeholder network (WP3). Specific surveys and interviews with local, national and international stakeholders were conducted to identify educational needs and skill gaps to be addressed.
3	Define specific competencies	Break down the desired outcome into specific learning outcomes, which are measurable and aligned with the overreaching goal of MCs.	The identified educational needs were translated into specific learning units which forms the MCs. A hierarchical framework for categorizing educational goals based on the Bloom's taxonomy (Fig. 4) was used to guide the development of learning objectives and to ensure that the learning objectives span across different levels to promote a comprehensive understanding and application of the subject.
4	Assessment methods	Determine appropriate assessment methods that align with the learning objectives and allow learners to demonstrate their proficiency in the targeted competencies.	Different assessment methods – such as, multiple choice questions, projects, practical exams, etc. – were considered for each MCs and fully described. The MOOC nature of RES4CITY educational programmes, which was chosen to reach the widest diffusion possible, has led to select multiple choice questions as the preferred assessment method. However, this does not preclude a future implementation of other assessment methods based on the MOOC platform capabilities.

n.	Step	Description	RES4CITY approach
6	Prioritize relevance and real-world application	Emphasize the practical application and relevance of the learning objectives	Practical learning with real-life examples and based on case study education was employed across all MCs, by leveraging on the lighthouse case studies (WP2), to ensure that the knowledge and skills acquired through the micro-credential can be directly applied in professional or real-life settings.
7	Review and refine	Continuous review and validation of the learning outcomes and MC contents with relevant stakeholder, including feedback from learners, to ensure their alignment with the educational needs identified.	The co-design process implemented by RES4CITY is based on a continuous interaction with relevant stakeholders through the Innovation and Stakeholders Network established in WP3. Each have gone through a both internal and external quality assessment by external advisory board, which provided feedback and suggestions. Despite no feedbacks from learners were available at the time of writing the present document, their collection and analysis through the MOOC platform is planned and they will be used to evaluate quality and students' satisfaction during and after the piloting phase.

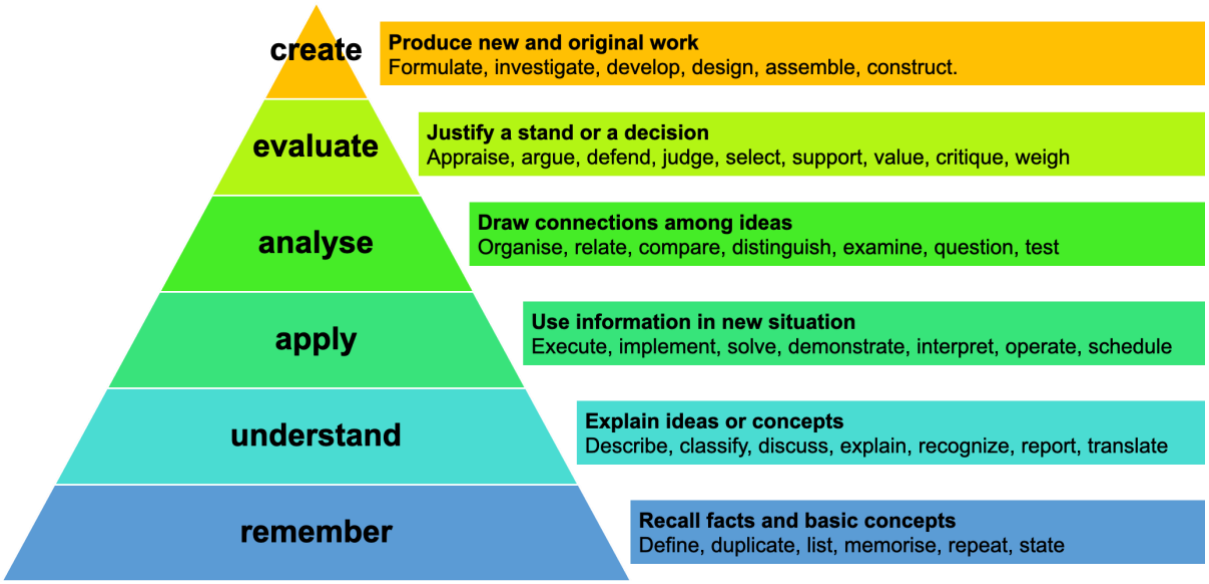

Figure 4: Bloom's taxonomy adopted for RES4CITY MCs basket development [11]

2.2 Micro-credential classification

According to the procedure outlined in Table 3 and Figure 4, a preliminary basket consisting of 74 micro-credentials has been identified and assessed based on several indexes and KPIs as follows:

- *Target audience*: Since RES4CITY targets students and professionals with both STEM (Science, Technology, Engineering and Mathematics) and NON-STEM background, the suitability of each MC for STEM/NON-STEM learners was assessed based on the MC contents and learning outcomes. Furthermore, specific prerequisites for each MC were identified to provide a preliminary indication to the learners about the knowledge and competences required to successfully complete the MC.

- *EQF level*: the European Qualification Framework [12] was adopted to classify each MC. The EQF is based on an 8-levels scale defined by a set of descriptors indicating the learning outcomes relevant to the specific qualification possessed by the learners. As mentioned in Table 3, RES4CITY's programmes target students at EQF 6-7-8, which correspond to the learning outcomes outlined in Table 4. Therefore, EQF level(s) have been assigned to each MC in the RES4CITY basket to identify the qualification level of its learning outcomes.

Table 4: Description of the learning outcomes of EQF 6-7-8 [11].

EQF level 6		
Knowledge	**Skills**	**Responsibility & autonomy**
Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups
EQF level 7		
Knowledge	**Skills**	**Responsibility & autonomy**
Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research Critical awareness of knowledge issues in a field and at the interface between different fields	Specialised problem-solving skills required in research and/or innovation to develop new knowledge and procedures and to integrate knowledge from different fields	Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams
EQF level 8		
Knowledge	**Skills**	**Responsibility & autonomy**
Knowledge at the most advanced frontier of a field of work or study and at the interface between fields.	The most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice.	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research.

- *International Standard Classification of Education – Fields of education and training* (ISCED-F): RES4CITY adopted the ISCED-F 2013 framework [13] as a reference to classify and organise the micro-credential basket based on its fields of education. ISCED was developed by the UNESCO in the mid-1970 and subsequently revised in 1997 and 2011 to reflect the changes in the educational systems occurred over the last decades. The ISCED-F focuses on the fields of education and training, and it was adopted by the EU as reference since 2014 [14]. Referencing to the detailed description of the education fields reported in [13], the ISCED-F codes reported in Table 5 were selected and used to indicate the main discipline (i.e., primary discipline) of each MC. It is important to highlight that due to the intrinsic multidisciplinary of RES4CITY's learning programmes, most of the MCs can be related to multiple disciplines. Consequently, secondary ISCED-F codes were assigned to each MC where relevant (i.e., complementary disciplines).

Table 5: ISCED codes and subjects [21]

ISCED-F	SUBJECT
031	Social and behavioural science (including economic and finance)
041	Business and administration
052	Environmental science
061	Information and communication technologies (including data science)
071	Engineering and engineering trades
072	Manufacturing and material
073	Architecture and construction

- *Size of the MC learning unit*: each MC in the RES4CITY basket was sized according to the European Credit Transfer and Accumulation System (ECTS), adopted by the European Higher Education Area (EHEA) and as suggested in [15], to support the transparency and stackability of the obtained credentials. According to the literature, no standard ECTS ranges for MCs are currently in place, the following principles were adopted to size RES4CITY MCs:
    - Since MC is intended to provide a specific learning outcome, its size must be large enough to allow a precise definition and delivery of its learning outcomes while avoiding to being confused with larger educational programmes. Therefore, a typical range is between 1 and 5 ECTS for a single micro-credential.
    - The total student's effort is estimated in the range of 25-30 hours per ECTS [16], including frontal lectures, practical sessions and individual study.

  Starting from the above, a size of 2.5 ECTS for all MC in the RES4CITY basket was selected as the most appropriate value since it allows:
    - to correctly define the learning outcomes of each MC.
    - to ensure a successful delivery of the MC content – i.e., video lectures, practical examples, reading materials, etc.
    - to organise each MC in week-based subunits with an average student effort (total) between 12 per subunit and a total duration between 6 and 4 weeks respectively for an average of 28.8 hours per ECTS, in line with the EHEA regulations.

  The course structure is designed by following a science-based approach to maximise attention, completion and understanding. Considering the MOOC nature of the MCs developed in RES4CITY, it is suggested that the length of each video-lectures is not greater than 10 minutes, and that the total duration of all video lectures is between 1 and 2 hours [17-19].

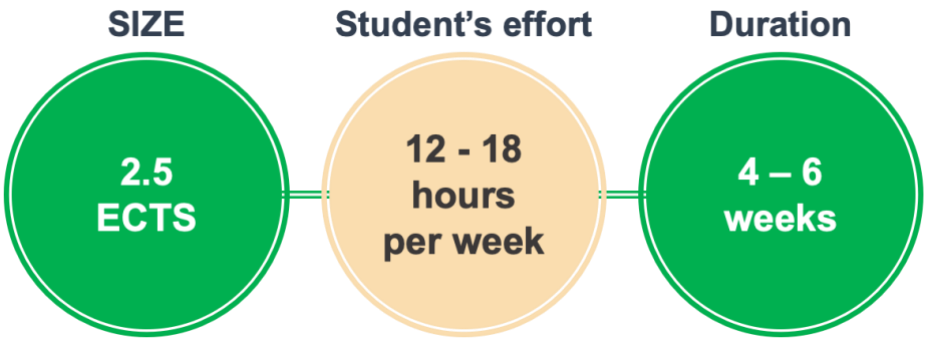

Figure 5: RES4CITY micro-credential size, duration and average student's effort

2.3 Structure definition

A proposal form for micro-credential was prepared and circulated among academic and non-academic partners of RES4CITY consortium, as well as to relevant stakeholders to collect proposals for the MC basket. The proposal form (Figure 6) outlined the structure of RES4CITY micro-credentials and included all the information required for the subsequent evaluations by the internal quality advisors and by external stakeholders, in line with the proposed co-design framework. MC proposals with a high degree of similarities in terms of learning outcomes were then merged in a single MC.

Figure 6: RES4CITY micro-credential proposal form

3. RES4CITY MICRO-CREDENTIAL BASKET

3.1 List of RES4CITY micro-credentials

The following table reports the list of all micro-credentials identified and co-designed for the RES4CITY MC basket with the related RES4CITY partner responsible based on their expertise related to the MC disciplines (see section 3.3), for the finalisation of learning outcomes and the definition of contents, prerequisites and teaching and assessment methods. The detailed description of each MC and the learning outcomes is reported in Annex A.

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Micro-credential proposal form

Institution:	Add your institution
Module coordinator:	Add the person responsible for the micro-credential
Lecturers:	Add the name(s) of all lecturers involved

MC title	Be concise (maximum 40 characters). Example: *Solar energy system design*				
MC long title	Add an extended title of the micro-credential for web display / marketing (max 100 characters)				
ISCED codes[1]	List all relevant ISCED codes	**EQF level**[2,3]		**ECTS**	3
Suitable for	☐ STEM ☐ NON-STEM				

Background of the proposed micro-credential
Add a short abstract (max 150 words) to explain the rationale for the micro-credential proposal in the context of renewable energies and fuel technologies development in urban areas.
Overview of the micro-credential
Short description (max 150 words) of the proposed micro-credential. The text provided here should be intended as the micro-credential abstract to be displayed in the course finder.
Learning objectives
On the completion of the micro-credential, participants should be able to: - List between 3 and 5 learning outcomes
Table of contents
- List all expected contents of the proposed micro-credential (max 100 words)
Teaching and learning methods
Outline the teaching and learning methods which will be used, for instance - Video lectures (what content and how long?) - Other teaching material such as presentations, data sheets, simulation codes, worked exercises, reading contents, etc.
Prerequisites
- Write any prerequisite of the proposed micro-credential, including any competence students should have to successfully attend the micro-credential.
Assessment methods[4]
- Describe the preferrable method(s) for assessing the students' learning outcomes.

[1] ISCED codes: max 3 codes; more information can be found at the following LINK
[2] EQF: more information can be found at the following LINK
[3] RES4CITY programmes targets students and professionals at EQF 6-7-8 levels
[4] The assessment methods under RES4CITY will be standardises as multiple-choice questions. For completeness of the description, we can identify other assessment methods (i.e., assignments, exercises, case studies, etc.) for each micro-credential.

Table 6: RES4CITY MC basket – Micro-credential list and partner's assignment

#	MC TITLE	RES4CITY partner	
		#	Partner
P01	Enacting a circular economy	1	NUIM
P02	Sustainable fashion	1	NUIM
P03	Introduction to sustainable finance	1	NUIM
P04	Tools, Strategies and Trends in Sustainable Finance	1	NUIM
P05	Investing in sustainability	1	NUIM
P06	Climate risk and climate investing	1	NUIM
P07	Data analytics for the energy sector	1	NUIM
P08	Electric Mobility and power system integration	1	NUIM
P09	Introduction to Sustainability in agriculture	1	NUIM
P10	Analysis of energy consumption	2	UNIGE
P11	Case studies in energy management	2	UNIGE
P12	Convection heat transfer	2	UNIGE
P13	Energy markets	2	UNIGE
P14	Case studies in thermal systems	2	UNIGE
P15	Basics of investment analysis	2	UNIGE
P16	Conduction heat transfer	2	UNIGE
P17	Energy efficiency financing	2	UNIGE
P18	Heat transfer in buildings	2	UNIGE
P19	Energy utilisation and storage	3	UCOI
P20	Energy consumption characterisation	3	UCOI
P21	Thermal simulation of buildings	3	UCOI
P22	Advanced modelling of buildings and energy systems	3	UCOI
P23	Energy strategy and energy transition	3	UCOI
P24	Energy management and smart communities	3	UCOI
P25	Sustainable development	3	UCOI
P26	Energy policy	3	UCOI
P27	Thermal energy storage	3	UCOI
P28	Decarbonisation of thermal energy	4	UPV
P29	Efficient building techniques	4	UPV
P30	Electricity storage	4	UPV
P31	Energy communities	4	UPV
P32	Fuel poverty solutions	4	UPV
P33	Nature-based solutions	4	UPV
P34	Positive energy districts	4	UPV
P35	Smart energy systems	4	UPV
P36	Tools for cities decarbonisation	4	UPV
P37	Energy consumption in buildings	5	UNISS
P38	Fundamentals of thermodynamics and heat transfer	5	UNISS
P39	Fundamentals of energy system	5	UNISS
P40	Introduction to renewable energies	5	UNISS
P41	Urban metabolism strategies	5	UNISS
P42	Digital payments and smart city platform	5	UNISS
P43	Circular materials for a sustainable manufacturing	5	UNISS
P44	Introduction to life cycle analysis of raw materials	5	UNISS
P45	Understanding critical raw materials	5	UNISS
P46	How sustainable is your city?	6	DTU
P47	Sustainable development goals for cities	6	DTU
P48	Network industries regulation and pricing	6	DTU
P49	Introduction to industrial organisation	6	DTU
P50	Building sustainable cities: the role of renewable energies	6	DTU
P51	Urban renewable energy: decision making methodologies	6	DTU
P52	Energy economics and policy	6	DTU

#	MC TITLE	RES4CITY partner	
		#	Partner
P53	Energy justice and poverty	6	DTU
P54	Regulatory framework conditions for Power-2-X	6	DTU
P55	Social acceptance of technologies	6	DTU
P56	Hydrogen technologies for urban areas	7.2	CNRS
P57	Cost and energy modelling	7.2	CNRS
P58	Decision-making for energy projects under uncertainty	7.1	INP-UGA
P59	Strategic behaviour in energy markets: options and games	7.1	INP-UGA
P60	Energy Policy and flexible technologies	7	UGA
P61	Renewable energy investments	7	UGA
P62	Electricity network regulation	7	UGA
P63	Positive energy buildings	7.1	INP-UGA
P64	Physics of Energy	7.1	INP-UGA
P65	Economics and physics of energy storages	7.1	INP-UGA
P66	Biogas systems for climate transition	12	HU
P67	Circular economy for sustainable cities	12	HU
P68	Management of innovation projects	12	HU
P69	Small scale wind power	12	HU
P70	Low-temperature district heating	12	HU
P71	Gender mainstreaming and intersectionality	12	HU
P72	Leadership development	12	HU
P73	Sustainable business models	12	HU
P74	Bank's financing of entrepreneurial firms	12	HU

3.2 Target groups

The following table reports the classification of all MCs in RES4CITY micro-credential basket based on their EQF level and suitability for STEM/NON-STEM audience.

Table 7: Micro-credential classification based on STEM/NON-STEM suitability and EQF level.

#	MC TITLE	STEM	NON-STEM	EQF LEVEL		
				6	7	8
P01	Enacting a circular economy	X	X		X	X
P02	Sustainable fashion	X	X	X	X	X
P03	Introduction to sustainable finance	X	X	X	X	X
P04	Tools, Strategies and Trends in Sustainable Finance	X	X	X	X	X
P05	Investing in sustainability	X	X	X	X	X
P06	Climate risk and climate investing	X	X		X	X
P07	Data analytics for the energy sector	X			X	X
P08	Electric Mobility and power system integration	X			X	X
P09	Introduction to Sustainability in agriculture	X	X	X	X	X
P10	Analysis of energy consumption	X	X		X	X
P11	Case studies in energy management	X			X	X
P12	Convection heat transfer	X			X	X
P13	Energy markets	X	X		X	X
P14	Case studies in thermal systems	X			X	X
P15	Basics of investment analysis	X	X	X	X	X
P16	Conduction heat transfer	X			X	X
P17	Energy efficiency financing	X	X		X	X
P18	Heat transfer in buildings	X			X	X
P19	Energy utilisation and storage	X		X	X	X
P20	Energy consumption characterisation	X		X	X	X
P21	Thermal simulation of buildings	X		X	X	

#	MC TITLE	STEM	NON-STEM	EQF LEVEL		
				6	7	8
P22	Advanced modelling of buildings and energy systems	X			X	X
P23	Energy strategy and energy transition	X	X	X	X	
P24	Energy management and smart communities	X	X		X	X
P25	Sustainable development	X	X	X	X	X
P26	Energy policy	X	X	X	X	X
P27	Thermal energy storage	X		X	X	
P28	Decarbonisation of thermal energy	X			X	X
P29	Efficient building techniques	X		X	X	
P30	Electricity storage	X			X	X
P31	Energy communities	X	X	X	X	
P32	Fuel poverty solutions		X	X	X	
P33	Nature-based solutions	X	X	X	X	
P34	Positive energy districts	X			X	X
P35	Smart energy systems	X			X	X
P36	Tools for cities decarbonisation	X			X	X
P37	Energy consumption in buildings	X		X	X	
P38	Fundamentals of thermodynamics and heat transfer	X		X		
P39	Fundamentals of energy systems	X	X	X	X	
P40	Introduction to renewable energies	X	X	X	X	
P41	Urban metabolism strategies	X	X	X	X	
P42	Digital payments and smart city platform	X	X	X		
P43	Circular materials for a sustainable manufacturing	X	X	X	X	
P44	Introduction to life cycle analysis of raw materials	X			X	X
P45	Understanding critical raw materials	X	X	X		
P46	How sustainable is your city?		X	X		
P47	Sustainable development goals for cities		X	X		
P48	Network industries regulation and pricing		X		X	X
P49	Introduction to industrial organisation		X	X		
P50	Building sustainable cities: the role of renewable energies		X	X	X	
P51	Urban renewable energy: decision making methodologies		X		X	X
P52	Energy economics and policy		X		X	X
P53	Energy justice and poverty		X	X		
P54	Regulatory framework conditions for Power-2-X	X				X
P55	Social acceptance of technologies		X	X		
P56	Hydrogen technologies for urban areas	X	X	X		
P57	Cost and energy modelling	X	X	X	X	
P58	Decision-making for energy projects under uncertainty	X	X	X	X	X
P59	Strategic behaviour in energy markets: options and games		X		X	X
P60	Energy Policy and flexible technologies	X	X		X	X
P61	Renewable energy investments	X	X	X	X	
P62	Electricity network regulation	X	X		X	
P63	Positive energy buildings	X			X	X
P64	Physics of Energy	X	X	X		
P65	Economics and physics of energy storages	X			X	X
P66	Biogas systems for climate transition	X		X		
P67	Circular economy for sustainable cities	X	X	X		
P68	Management of innovation projects	X	X	X		
P69	Small scale wind power	X		X	X	
P70	Low-temperature district heating	X		X		
P71	Gender mainstreaming and intersectionality		X	X		
P72	Leadership development		X	X		
P73	Sustainable business models		X	X		

#	MC TITLE	STEM	NON-STEM	EQF LEVEL		
				6	7	8
P74	Bank's financing of entrepreneurial firms		X	X		

3.4 ISCED-F matrix

Each micro-credential (Table 6) was classified based on the ISCED-F codes reported in Table 5 to indicate its primary discipline and the complementary disciplines, as outlined in section 2.2. Figure 7 reports the resulting ISCED-F classification based on the number of occurrences of both primary and complementary ISCED-F codes assigned to each MC in the micro-credential basket. It can be observed that engineering (ISCED-F 071), business and administration (ISCED-F 041) and manufacturing and material (ISCED-F 072) are the most frequent primary disciplines of the RES4CITY MCs basket. On the other hand, social and behavioural science (ISCED-F 031), environmental science (ISCED-F 052), and information and communication technologies (ISCED-F 061) are represented mostly as complementary disciplines, which highlights the multidisciplinary approach adopted by RES4CITY in designing the MCs basket.

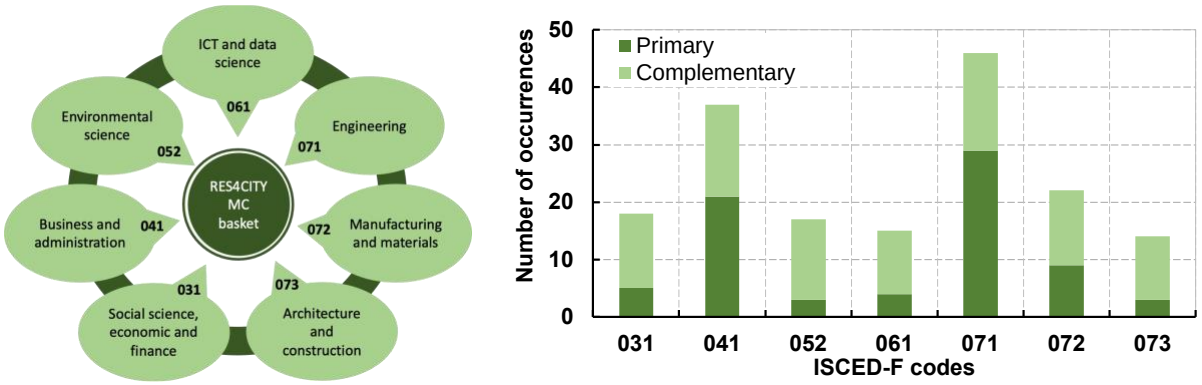

Figure 7: ISCED-F classification of the RES4CITY micro-credential basket

This is also confirmed in Figure 8, which shows the share in percentage of primary and complementary disciplines of the RES4CITY micro-credential basket. Observing the share of primary disciplines (Figure 8a), it can be noted that 41% of all MCs fall into the engineering field (ISCED-F 041), while 30% have a core discipline in business and administration (ISCED-F 041). The remaining MCs (i.e., 29%) are classified as manufacturing and materials (ISCED-F 071, 9%), social and behavioural science (ISCED-F 031, 8%), environmental science (ISCED-F 052, 5%), architecture and planning (ISCED-F 073, 4%) and information and communication technology (ISCED-F 061, 3%) as core disciplines.

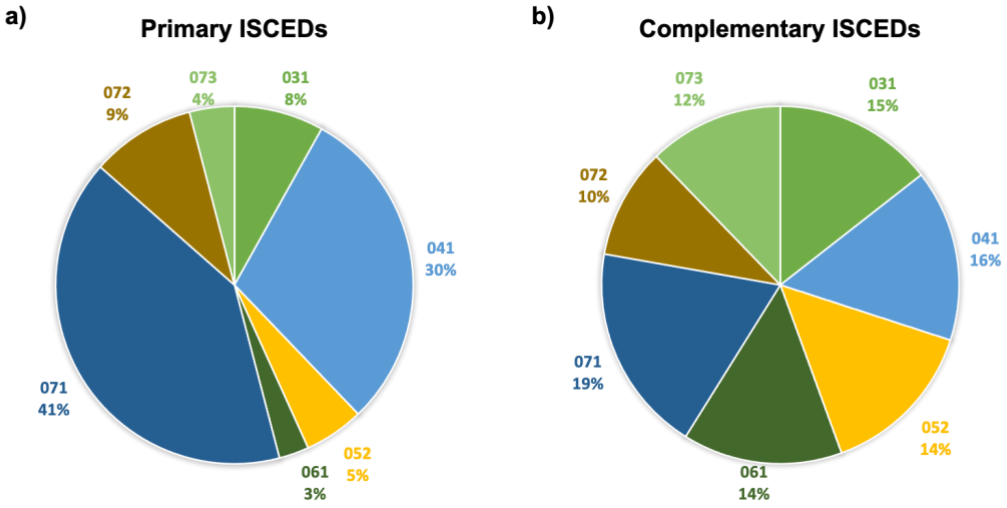

Figure 8: Share of primary (a) and complementary (b) ISCED-F of the RES4CITY Micro-credential basket

The multidisciplinary aspect of RES4CITY's micro-credential basket is highlighted by the complementary disciplines assigned to all MCs, where relevant (Figure 8b). It can be observed that the all ISCED-F codes show a similar share of occurrence across all MCs, from 10% of manufacturing and materials (ISCED-F 042) to the 19% of the engineering discipline (ISCED-F 071). Notable is the share of information and communication technology (ISCED-F 061, 16%), which highlights the need of acquiring transversal digital skills across all MC in the basket.

The following table reports the discipline classification of each selected MC in terms of ISCED-F codes, highlighting both primary (P) and complementary (C) fields.

Table 8: MC basket assessment based on ISCED codes (P: primary discipline; C: complementary discipline)

#	MC TITLE	ISCED codes						
		031	041	052	061	071	072	073
P01	Enacting a circular economy			C			P	
P02	Sustainable fashion		C	C			P	
P03	Introduction to sustainable finance	C	P					
P04	Tools, Strategies and Trends in Sustainable Finance		P					
P05	Investing in sustainability		P					
P06	Climate risk and climate investing		P					
P07	Data analytics for the energy sector				P			
P08	Electric Mobility and power system integration				C	P		
P09	Introduction to Sustainability in agriculture			C			P	
P10	Analysis of energy consumption	C				P		
P11	Case studies in energy management		C			P	C	
P12	Convection heat transfer					P		
P13	Energy markets	C	C			P		
P14	Case studies in thermal systems		C		C	P		
P15	Basics of investment analysis		P					
P16	Conduction heat transfer					P		
P17	Energy efficiency financing		P			C		
P18	Heat transfer in buildings					P	C	C
P19	Energy utilisation and storage		C		C	P		
P20	Energy consumption characterisation					P		
P21	Thermal simulation of buildings				C	P		C
P22	Advanced modelling of buildings and energy systems				C	P		C
P23	Energy strategy and energy transition		P	C		C		

#	MC TITLE	ISCED codes						
		031	041	052	061	071	072	073
P24	Energy management and smart communities	C				P		
P25	Sustainable development	P	C	C		C	C	
P26	Energy policy		P	C		C	C	
P27	Thermal energy storage					P		
P28	Decarbonisation of thermal energy					P		C
P29	Efficient building techniques					C	C	P
P30	Electricity storage					C	P	
P31	Energy communities	C				P		
P32	Fuel poverty solutions	P	C			C		
P33	Nature-based solutions			C			C	P
P34	Positive energy districts	C				P		C
P35	Smart energy systems				C	P		
P36	Tools for cities decarbonisation	C		C	P	C		C
P37	Energy consumption in buildings					P		C
P38	Fundamentals of thermodynamics and heat transfer					P		
P39	Fundamentals of energy systems			C		P		
P40	Introduction to renewable energies			C		P	C	
P41	Urban metabolism strategies			C			C	P
P42	Digital payments and smart city platform		P		C			
P43	Circular materials for a sustainable manufacturing			C			P	
P44	Introduction to life cycle analysis of raw materials			C			P	
P45	Understanding critical raw materials			C			P	
P46	How sustainable is your city?	C		P			C	C
P47	Sustainable development goals for cities	C		P			C	C
P48	Network industries regulation and pricing		P			C		
P49	Introduction to industrial organisation		P					
P50	Building sustainable cities: the role of renewable energies	C		C		P		C
P51	Urban renewable energy: decision making methodologies	C	P			C		
P52	Energy economics and policy	C	P			C		
P53	Energy justice and poverty	P	C			C		
P54	Regulatory framework conditions for Power-2-X		C			P		
P55	Social acceptance of technologies	P	C					
P56	Hydrogen technologies for urban areas		C			C	P	
P57	Cost and energy modelling		P		C	C		
P58	Decision-making for energy projects under uncertainty		P		C			
P59	Strategic behaviour in energy markets: options and games		C		P			
P60	Energy Policy and flexible technologies		P		C			
P61	Renewable energy investments		P			C		
P62	Electricity network regulation		P			C		
P63	Positive energy buildings				C	P		C
P64	Physics of Energy					P		
P65	Economics and physics of energy storages		C			P	C	
P66	Biogas systems for climate transition			C		C	P	
P67	Circular economy for sustainable cities			P			C	
P68	Management of innovation projects	C	P					
P69	Small scale wind power			C		P		
P70	Low-temperature district heating					P		C
P71	Gender mainstreaming and intersectionality	P	C					
P72	Leadership development	C	P					
P73	Sustainable business models		P				C	
P74	Bank's financing of entrepreneurial firms		P					

4. CONCLUSIONS AND FINAL REMARKS

RES4CITY is dedicated to fostering the growth of a proficient workforce by championing sustainability and circularity within the realm of renewable energy and fuel technologies, particularly within urban settings. This mission is pursued through a ground-breaking educational initiative that is collaboratively crafted alongside stakeholders. This innovative educational program serves as a gateway for individuals to cultivate specialized skills and expertise, in response to the European Union's overarching objective of advancing digital literacy and lifelong learning. The focal point of RES4CITY's educational programs is centred on the realm of renewable energy and sustainable fuel technologies, with a particular emphasis on devising strategies tailored for urban environments.

To reach these objectives, RES4CITY identified a curated collection of multidisciplinary micro-credentials to create a MCs basket that cater to a diverse audience encompassing both students and professionals, regardless of whether they possess a STEM or non-STEM background. The present report described the RES4CITY micro-credential basket, outlining the methodology adopted for the identification of the learning objectives, definition of MC contents and learning methods, target groups and subjects covered. A total of 74 MCs, codesigned with relevant stakeholders, were identified and assessed based on target audience (STEM/NON-STEM), European Qualification Framework (EQF) level, disciplines (ISCED-F codes), learning unit size and student's effort, etc. The following tables provides a summary overview of the RES4CITY MCs basket.

Table 9: Overview of RES4CITY MCs basket

RES4CITY MCs basket overview							
MCs number	74						
Single MC size	2.5 ECTS						
Average time to MC completion	4-6 weeks						
Average student's effort (estimated)	12-18 hours / week						
Target groups	**STEM oriented**		**NON-STEM oriented**		**Both STEM/NON-STEM**		
MCs number	27		15		32		
EQF levels	**EQF 6**		**EQF 7**		**EQF 8**		
MC numbers	45		55		39		
Disciplines (ISCED-F codes)*	**031**	**041**	**052**	**061**	**071**	**072**	**073**
Primary	8%	30%	5%	3%	41%	9%	4%
Complementary	15%	16%	14%	14%	19%	10%	12%

031: Social and behavioural science (including economic and finance)
041: Business and administration
052: Environmental science
061: Information and communication technologies (including data science)
071: Engineering and engineering trades
072: Manufacturing and material
073: Architecture and construction

RES4CITY KPIs			
KPI	**Description**	**Target**	**Value**
-	Number of micro-credentials identified	55	74
1	Focussed on social and environmental aspects (air pollution, waste management, job opportunities, wildlife concerns, etc.) of RES and RFT.	15	19
5	Co-designed for the development of training and reskilling opportunities in RES and RFT	18	19
11	Focussed on the Circular Economy Action Plan, Critical Raw Material, recycling by design	21	26

Starting from the MCs basked described in the present report, RES4CITY consortium will define 8 multidisciplinary micro-programmes designed to facilitate the acquisition of multidisciplinary skills and competencies to support the upskilling and retraining of the workforce in the field of renewable energy and fuel technologies in urban areas. The programmes will be based on a selection of 44 micro-credentials chosen from the RES4CITY MCs basket described in the present document, which will be refined and produced by the consortium. The full description of the programmes can be found in the RES4CITY deliverable 2.4.

Furthermore, the present report serves as a guideline for the identification, co-design and assessment of micro-credentials for future replication and extension of the RES4CITY basket. With a keen awareness of emerging technologies and societal needs, the micro-course portfolio will be expanded to encompass cutting-edge topics, ensuring that learners remain at the forefront of innovation. To reach this goal, collaboration with stakeholders needs to be intensified further, forming the bedrock for the co-design of micro-credentials that remain agile and responsive to evolving industry demands. This collaborative ethos ensures that RES4CITY remains a dynamic force, consistently providing learners with the most relevant and up-to-date knowledge and skills.

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APPENDIX A – RES4CITY's micro-credentials

MC-P01: Enacting a circular economy

MC title	Enacting a Circular Economy		
MC long title	Enacting a Circular Economy with Sustainable Energy Use		
ISCED codes	*Primary*: 072	*Complementary*: 052	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
To enact a circular economy, and move towards sustainable energy usage, it is critical that we have an understanding of and can critically engage with environmental world views. Furthermore, the development of multi-stakeholder partnerships with regards to renewable energy materials and the development of new policy and legislation in this sphere is imperative. The Energy and the Circular Economy MC will support the development of knowledge and skills around the concept of the circular economy, specifically focusing on sustainable energy usage.			
Overview of the micro-credential			
This MC will introduce the skills and attributes required for critical reflection and action on creating a circular economy with sustainable energy use. Learners will be introduced to the concept of environmental world views, and the impact that these can have on collective action. Through thought experiments and case studies, learners will critically reflect on their own personal views. Students will learn about the current initiatives, opportunities and challenges associated with enacting a circular economy, and how best to plan for multi-stakeholder involvement in energy-related initiatives.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Contextualise and reflect on environmental world views. • Comprehend and critically engage with the role of energy use in the circular economy. • Contextualise theory and relate this to varying societal groups' Ability, Motivation and Opportunity to enact a circular economy with sustainable energy use. • Carry out stakeholder mapping and circular economy project planning activities.			
Table of contents			
• Reflect on Environmental World Views and Ethics • Introduction to the Circular Economy and Sustainable Energy Use • Explore and Critically Evaluate Energy Innovation Case Studies • Investigate the Role of Societal Actors in Enacting a Circular Economy • Development of Interdisciplinary Partnerships for Circular Economy Action			
Teaching and learning methods			
The following teaching and learning methods will be used: • Teaching & Learning Methods: Video lectures (6 hours), case studies, academic papers, videos, audio clips & media articles.			
Prerequisites			
None			
Assessment methods			
Multiple choice questions			

MC-P02: Sustainable fashion

MC title	Sustainable fashion		
MC long title	Sustainable Fashion: sustainable business models and technological capabilities		
ISCED codes	*Primary*: 072	*Complementary*: 041, 052	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7-8

Background of the proposed micro-credential

The fashion industry is one of the most wasteful consumer industries in the world. The global presence of a few industry giants is greatly impacting the competitive paradigm and has resulted in the creation of 'fast fashion' – a race to the bottom from an economic and environmental perspective. There is a growing need to address the industry's unsustainable practices and remediate the damage it is causing to ensure its viability in Europe's green future. Given the immediacy of climate action responses necessary to meet carbon reduction goals the fashion industry must change quickly to maintain relevance in the new green paradigm. Digitalisation, renewable energies, and advanced manufacturing innovations hold the key to regaining balance in the fashion industry. The factors and elements that shape the fashion industry are examined in addition to the tools and mechanisms that can enable it to change.

Overview of the micro-credential

This module explores the factors that impact sustainability in the fashion industry. The fashion ecosystem and stakeholder competitive dynamics are examined to understand the various drivers within the industry. Through developing an understanding of existing fashion industry business models, we explore the factors that are driving sustainability-oriented change within the industry (e.g., circular economy principles; consumer awareness and demand; United Nation's Sustainable Development Goals; carbon credits; etc.). Emergent technological advances, with the potential to radically alter fashion production, will also be explored; in addition to the ways such technologies can support carbon reduction within the fashion industry. Students will learn how to examine an industry through the lens of sustainability and gain an appreciation for the push and pull factors that lead to sustainable environmental change within a highly consumerist market.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- Analyse competitive dynamics within the fashion industry through a sustainability lens
- Evaluate the drivers of sustainability-oriented change within the fashion industry
- Comprehend the dynamics of a highly consumerist market
- Evaluate the potential impact of emergent technological advances on the fashion industry

Table of contents

- Fashion industry ecosystem and stakeholder competitive dynamics.
- Current successful fashion industry business models (case studies).
- Push factors: drivers of sustainability-oriented change within the industry.
- Pull factors: The role of the consumer in demand driven change.
- Emergent technological advances impacting the fashion industry.
- The impact of digitalisation on the fashion industry (case studies).
- Considering future business models in the fashion industry.

Teaching and learning methods

The following teaching and learning methods will be used:

- Teaching & Learning Methods: Video lectures case studies work (4 cases), academic papers, videos, audio clips & media articles.

Prerequisites

None

Assessment methods

Multiple choice questions

MC-P03: Introduction to sustainable finance

MC title	Introduction to sustainable finance		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 031	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7-8
Background of the proposed micro-credential			
Sustainable finance is a broad and evolving field that aims to align financial decision-making with environmental, social, and governance (ESG) considerations. It involves integrating sustainability principles into investment decisions, lending practices, and overall financial strategies. The goal of sustainable finance is to support projects and businesses that contribute positively to the environment and society while mitigating risks associated with unsustainable practices. Key components of sustainable finance include impact investing, which focuses on generating measurable social and environmental benefits alongside financial returns. Environmental and social risk assessments help investors and financial institutions evaluate the sustainability performance of companies and projects. Additionally, sustainable finance encourages the integration of ESG factors into corporate reporting and decision-making processes, fostering greater transparency and accountability.		
Overview of the micro-credential			
The MC "Introduction to Sustainable Finance" offers the tools and insights needed to develop financial strategies that create value for society and invest in a sustainable future. Students will learn about the pressures, trends, and opportunities in the current financial system. They will investigate the strategic business implications of social and environmental challenges and discover how best to plan through sustainable initiatives like impact investing, the integration of Environmental, Social, and Governance (ESG) investing, and positive screening.		
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Understand the pressures, trends, and opportunities within the current financial system related to sustainable finance. • Analyse the strategic business implications of social and environmental challenges in the context of sustainable finance. • Develop financial strategies that create value for society and contribute to a sustainable future. • Explore sustainable initiatives like impact investing, ESG integration, and positive screening for responsible and impactful investment decisions.		
Table of contents			
• Introduction to the current financial system. • Capital flow in the financial system. • Sustainable finance approaches. • The role of the public sector in sustainable finance.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures on the introduction to sustainable finance with interactive features with H5P • Presentations and data sheets • Worked exercises (case studies) • Teaching aids and research papers.			
Prerequisites			
Basic understanding of the global financial system and main definitions of macro-economic aggregation.			
Assessment methods			
Multiple choice questions			

MC-P04: Tools, strategies and trends in sustainable finance

MC title	Tools, Strategies and Trends in sustainable finance		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7-8
Background of the proposed micro-credential			
Sustainable finance is revolutionizing the financial landscape by incorporating environmental, social, and governance (ESG) considerations into decision-making. Investors leverage tools like impact investing, green bonds, and sustainable equity funds to align their portfolios with responsible principles. ESG integration assesses the sustainability performance of investments, while engagement empowers investors to drive positive change within companies. Continuously evolving trends, such as increased demand for sustainable products and climate-related disclosures, are reshaping financial markets. Sustainable finance's transformative power lies in its ability to foster a more resilient and responsible future, paving the way for a sustainable and equitable world.			
Overview of the micro-credential			
The MC "Tools and Strategies in Sustainable Finance" builds on the knowledge gained in the Introduction to Sustainable Finance (P03) and offers tools and insights needed to implement sustainable finance solutions in the student's own context, and better understand how these strategies can positively impact their organisation's long-term value gain. This module will also give them new perspectives on how businesses, banks, and insurers are shifting to more sustainable business models that offer positive returns for both their clients and society.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • implement sustainable finance solutions in the student's own context, applying tools and insights gained from the course. • Understand the positive impact of sustainable finance strategies on their organization's long-term value. • Gain new perspectives on how businesses, banks, and insurers are adopting more sustainable business models for positive returns. • Identify opportunities for creating positive societal impacts through sustainable finance practices.			
Table of contents			
• Relationship between risk and return, and the impact on sustainable finance. • Key attributes for promoting sustainable finance. • Megatrends and the innovations required to support a sustainable finance. • Action plan development to promote sustainable finance.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures on the introduction to sustainable finance with interactive features with H5P • Presentations and data sheets • Worked exercises (case studies) • Teaching aids and research papers.			
Prerequisites			
Micro-credential P03.			
Assessment methods			
Multiple choice questions			

MC-P05: Investing in sustainability

MC title	Investing in sustainability		
MC long title	Investing in sustainability: ESG Scoring, Investing and the Risk Premium		
ISCED codes	*Primary*: 041	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7-8

Background of the proposed micro-credential

Investors are increasingly seeking investment opportunities that align with environmental, social and governance (ESG) objectives to enhance fund performance. Today's business environment demands more than just acknowledging sustainability challenges; organizations are expected to take proactive leadership roles in addressing them. Leading through sustainability is crucial for remaining competitive and relevant. Embracing sustainability as a core principle not only contributes to a more sustainable future but also attracts conscious investors, fosters employee engagement, and builds customer loyalty. By seizing opportunities presented by sustainable investments, organizations can navigate the transformative investment landscape and become responsible agents of positive change.

Overview of the micro-credential

The MC "Investing in Sustainability" focuses on ESG Investing and examines the motivations behind ESG investing and the challenges involved in integrating this into existing investment processes. It is designed for practitioners or aspiring professionals across the financial services sector looking to improve their understanding of ESG issues. This course builds on an understanding of the fundamentals of investment management and offers the tools and insights needed to develop financial strategies that create value for society and invest in a sustainable future.

Learning objectives

On the completion of the micro-credential, participants will:

- Gain a comprehensive understanding of ESG Investing, including the motivations and drivers behind this approach.
- be able to analyse the challenges involved in integrating ESG considerations into existing investment processes.
- develop practical skills and tools to implement ESG strategies and enhance investment decision-making.
- have improved understanding of ESG issues and their impact on financial strategies and investment management in the pursuit of creating value for society and fostering a sustainable future.

Table of contents

- Climate urgency and action plan
- Climate risk measures
- Climate Investing: strategies for portfolio decarbonization
- Net Zero Carbon Metrics for portfolios

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures on the introduction to sustainable finance with interactive features with H5P
- Presentations and data sheets
- Worked exercises (case studies)
- Teaching aids and research papers.

Prerequisites

Micro-credential P01.

Assessment methods

Multiple choice questions

MC-P06: Climate risk and climate investing

MC title	Climate Risk & Climate Investing		
MC long title	Climate Investing, Risk Measures & Portfolio Decarbonization		
ISCED codes	*Primary*: 041	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
Responsible Investors are increasingly paying more attention not only to the transition risk but also to physical risk, the financial losses that come from climate change (droughts, floods, storms, etc.), not from the adaptation of the economy to prevent these losses. These concerns go beyond looking for investment opportunities that meet environmental, social and governance (ESG) objectives, while enhancing the value of investing performance. In today's business environment, it is, therefore, no longer sufficient for organisations to simply acknowledge global sustainability challenges like climate change, resource depletion, and inequality – they're expected to lead the way through them.			
Overview of the micro-credential			
The MC "Climate Risk & Climate Investing" examines the motivations behind Climate investing, by examining climate risks transmission channels to financial stability, and the challenges involved in integrating climate risk into existing investment processes. It is designed for practitioners or aspiring professionals across the financial services sector looking to improve their understanding of ESG issues. This course builds on an understanding of the fundamentals of investment management and offers the tools and insights needed to develop financial strategies that create value for society and invest in a sustainable future.			
Learning objectives			
On the completion of the micro-credential, participants will: • Understand the motivations and drivers behind Climate investing, including the examination of climate risk transmission channels to financial stability. • be able to analyse the challenges involved in integrating climate risk considerations into existing investment processes. • develop practical skills and tools to implement climate risk strategies and enhance investment decision-making in the context of climate investing. • possess an improved understanding of climate-related issues and their impact on financial strategies and investment management.			
Table of contents			
• The environmental, social and governance (ESG) scoring • Performance of ESG Investing. • ESG Financing & the cost of debt. • ESG Risk Premium.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures on the introduction to sustainable finance with interactive features with H5P • Presentations and data sheets • Worked exercises (case studies) • Teaching aids and research papers.			
Prerequisites			
Micro-credential P01.			
Assessment methods			
Multiple choice questions			

MC-P07: Data analytics for the energy sector

MC title	Data analytics for the energy sector		
MC long title	-		
ISCED codes	*Primary*: 061	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

Data analytics in the energy sector involves the systematic extraction, organization, and analysis of vast amounts of data to derive valuable insights, optimize operations, and inform decision-making. As the energy industry becomes more complex and data-driven, leveraging data analytics has become imperative for driving efficiency, sustainability, and innovation. Through advanced data analytics techniques, such as machine learning and predictive modelling, energy companies can optimize energy production and distribution, identify energy consumption patterns, and forecast demand fluctuations. Moreover, data analytics aids in identifying potential areas for energy savings, improving asset performance, and enhancing customer experiences. By harnessing the power of data analytics, the energy sector can revolutionize its operations, increase renewable energy integration, and contribute to a more sustainable and resilient energy future.

Overview of the micro-credential

The MC "Data Analytics for the Energy Sector" provides a comprehensive overview of leveraging data analytics in the dynamic energy industry. Participants will learn advanced techniques such as machine learning and predictive modeling to analyze vast datasets, optimize energy production, and identify consumption patterns. The course focuses on improving operational efficiency, enhancing asset performance, and fostering sustainable practices. Through practical applications and real-world case studies, participants will gain the skills needed to drive innovation, make data-informed decisions, and contribute to a more resilient and sustainable energy future.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- Understand the role of data analytics in the energy industry.
- Identify the different types of data sources and systems used in the energy sector.
- Use data visualization and dashboarding techniques.
- Apply statistical and predictive modelling methods to analyse energy data.
- Analyse real-world case studies from the energy industry and develop solutions to real-world problems using data analytics techniques.

Table of contents

- Introduction to data analytics in the energy sector
- Energy data sources and systems
- Energy data visualization and dashboarding
- Energy data analysis and modelling
- Case studies in energy data analytics

Teaching and learning methods

The following teaching and learning methods will be used:

- Lectures and presentations: The instructor could provide video lectures (3 hours) and presentations on key concepts and techniques in data analytics, using slides, videos, and other multimedia tools to support the material.

Prerequisites

Basic knowledge of data concepts and techniques, such as data types, data sources, data cleaning, and data visualization.
Familiarity with programming (e.g., python, R, etc.) and statistical analysis (Excel or SPSS).

Assessment methods

Multiple choice questions

MC-P08: Electric mobility and power system integration

MC title	Electric Mobility and Power System Integration		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 061	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

The widespread adoption of EVs can significantly increase the demand for electricity, especially during peak hours, which can put strain on the grid and require additional investments in generation, transmission, and distribution infrastructure. Therefore, the integration of EVs into the power system requires careful planning and coordination to ensure that the grid can accommodate the increased demand and avoid disruptions or blackouts.

Overview of the micro-credential

The course that provides an overview of the current state and future developments of electric vehicles (EVs) and their integration into the power system. The course covers topics such as the different types of EVs and their technical characteristics, the charging infrastructure and technologies, the impact of EVs on the power system and the grid, and the strategies and policies for the successful integration of EVs into the energy system. The course also discusses the benefits and challenges of EVs and their role in the transition towards a more sustainable and resilient energy system. Through lectures and hands-on activities, the course aims to equip students with the knowledge and skills to understand and analyse the opportunities and challenges of electric mobility and its integration into the power system.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- Understand the different types of EVs and their technical characteristics, such as range, performance, efficiency, and emissions.
- Gain knowledge of the charging infrastructure and technologies, including the different types of charging stations, their capabilities and limitations, and the standards and regulations.
- Understand the impact of EVs on the power system, including the potential increase in electricity demand, the opportunities and challenges of vehicle-to-grid (V2G) technologies, and the integration of EVs with renewable energy sources.
- to analyse and evaluate the strategies and policies for the integration of EVs into the power system, such as charging tariffs, subsidies, and regulations.

Table of contents

- Introduction to electric mobility: EV global landscape, charging infrastructure, standards and regulation.
- Impact of EVs on the power system: opportunities and challenges of vehicle-to-grid (V2G) technologies.
- Integration of EVs with renewable energy sources.
- Economic and financial schemes.
- Analysis of real-world examples and case studies of EV deployment and integration

Teaching and learning methods

The following teaching and learning methods will be used:

- Lectures and presentations: The instructor could provide video lectures (3 hours) and presentations on key concepts and techniques in data analytics, using slides, videos, and other multimedia tools to support the material.

Prerequisites

Basic knowledge of electric power system and familiarity with renewable energy sources.
Knowledge of the basic concepts of transportation and mobility.
Basic mathematical and computational skills, including algebra and basic programming skills.

Assessment methods

Multiple choice questions

MC-P09: Introduction to sustainability in agriculture

MC title	Introduction to sustainability in agriculture		
MC long title	-		
ISCED codes	*Primary*: 072	*Complementary*: 052	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7-8
Background of the proposed micro-credential			
The development of a sustainable food production system to feed a growing worldwide population is one of the major challenges facing society. The agricultural industry is a large contributor to greenhouse gas emissions and everyone in society has a responsibility to contribute to achieving a reduction of emissions in this area. Both rural and urban agriculture has an important role to play in achieving this. This MC will support the development of knowledge and skills around sustainability in agriculture initiatives which will assist in creating a more sustainable food supply.			
Overview of the micro-credential			
The MC "Introduction to Sustainability in Agriculture" offers the insights and knowledge needed to assist in the development of a sustainable food supply. Students will learn about the challenges and opportunities that exist in the agricultural industry regarding sustainable food production. An insight to initiatives being developed in the agricultural industry to reduce greenhouse gas emission will also be provided, along with a review of the indicators being used to measure sustainability in agriculture. Students will investigate the strategic business implications of the challenges faced by the agricultural industry across the three pillars of Environmental, Social, and Economic Sustainability.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • appraise current challenges and opportunities that exist in the development of a sustainable food supply • assess sustainability in agriculture using a variety of sustainability indicators • assess both the short-term and long-term impact of initiatives aimed to improve sustainability in agriculture • develop informed and innovative solutions to complex agricultural industry sustainability issues			
Table of contents			
• Introduction to the environmental, social, and economic pillars of sustainability in agriculture • Overview of the challenges and opportunities that exist to the development of a sustainable food supply. • Review of indicators to measure sustainability in agriculture. • Explore various initiatives being adopted by food producers to reduce greenhouse gas emissions. • Investigate the role of both rural and urban citizens in creating a sustainable food supply.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Recorded lecturers on the introduction to sustainability in agriculture. • Case studies on sustainability in agriculture initiatives. • Presentations, worked exercises, teaching aids, and research papers			
Prerequisites			
None			
Assessment methods			
Multiple choice questions			

MC-P10: Analysis of energy consumption

MC title	Analysis of energy consumption		
MC long title	Introduction to Fundamental Methodologies for energy consumption analysis		
ISCED codes	*Primary*: 071	*Complementary*: 031	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

The present MC will support the development of knowledge and skills to analyse the rationale behind energy consumption of a given territorial energy system (e.g., at country level, regional level, city level, urban district level, etc.). The analysis of the consumption trend is relevant to assess the effectiveness of implemented energy policies as well as to understand how the energy consumption structure can evolve in the future. A mix of technical and socio-economic variables will be considered to develop adequate quantitative analyses to suggest informed decisions to policy makers or companies based on an analytical framework.

Overview of the micro-credential

The MC "Analysis of Energy Consumption" will provide an overview of analytical methods for analysing the trend of energy consumption from a system of any territorial extension (e.g., country level, regional level, city level, etc.). A mix of simple (e.g., intensity estimation, growth rates, etc.) and more complex (e.g., weather adjustment, decomposition analysis, etc.) analytical frameworks will be introduced. The aim is to interpret the time trend of energy consumption with reference to total consumption or to a specific source (e.g., electricity consumption, natural gas consumption, etc.). Technical and socio-economic variables will be employed for the definition of significant indexes and KPIs to explain the consumption trend.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- Identify the components influencing the energy consumption
- Calculate relevant KPIs for the analysis of energy consumption
- Compare the main features of energy consumption trend for different systems (e.g., countries, cities, etc.)
- Recognize the effect of different energy policies on the consumption trend

Table of contents

- Introduction of the problem of energy consumption.
- Analysis of the energy consumption mix, concept of energy intensity.
- Compound Annual Growth Rate, elasticity of energy consumption, linear correlation index, weather adjustment procedure.
- Introduction to the Decomposition Analysis Index, additive decomposition methodology, implementation of the Logarithmic Mean Divisia Index approach for the decomposing energy consumption.

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, 3 hours, on the introduction of the problem of energy consumption, definition of simple KPI and energy consumption decomposition methodology
- Presentations, data sheets, worked exercises, teaching aids, and research papers

Prerequisites

Knowledge of the main units of measures used in the energy field.
Basic understanding of the main definitions of macro-economic aggregations (e.g., GDP, value added, etc.).

Assessment methods

Multiple choice questions

MC-P11: Case studies in energy management

MC title	Case studies in energy management		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 041	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
The present MC will support the development of knowledge and skills to solve practical multidisciplinary problems in Energy Management. The application of quantitative technical and economic methodologies is paramount in the development of business cases supporting the investment process with specific reference to the energy field (e.g., energy efficiency, RES development, etc.). This MC provides practical insight to develop a quantitative decision-making framework supporting energy investments.			
Overview of the micro-credential			
The MC "Case Studies in Energy Management" will combine technical and financial techniques for developing quantitative models for the development of business cases. Five cases will be illustrated and commented during this MC. The aim is to provide a practical applicable framework to develop independent evaluations with specific focus on energy efficiency and RES investments. Spreadsheet based models will be introduced to develop the necessary calculations. The concepts of sensitivity and scenario analyses will be also introduced.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Illustrate the logic for defining techno-economic models • Develop quantitative models for the development of energy-based business cases • Analyse different business cases based on technical and financial indicators • Propose quantitative conclusions			
Table of contents			
• Estimation of energy generation from RES and conventional power and heating plants. • Estimation of energy efficiency savings from energy efficiency interventions. • Concept of Levelized Cost of Energy (LCOE) and Levelized Cost of Heat (LCOH) • Drafting a flexible calculation spreadsheet, combination of technical and financial evaluation, calculation of financial indicators (i.e., Net Present Value, Internal Rate of Return, Pay Back Period, Profitability Index). • Development of 5 practical case studies.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures (3 hours) on the analysis and solution of 5 practical case studies • Presentations, data sheets, worked exercises, teaching aids, and research papers			
Prerequisites			
Knowledge of the main units of measures used in the energy field. Fundamentals of energy concepts. Basics on financial analysis.			
Assessment methods			
Multiple choice questions and solution of case studies.			

MC-P12: Convection heat transfer

MC title	Convection heat transfer		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
The present MC will support the development of knowledge and skills to understand the physics of convection heat transfer. A rigorous theoretical analysis of the topic will be proposed since it is relevant for all the energy application. The comprehension of convective phenomena supports the development of innovative applications in the field of renewables and energy efficiency. A precise mathematical and quantitative approach will be pursued in this MC. All the concepts of this MC will be fundamental to understand more applied topics related to specific applications/devices.			
Overview of the micro-credential			
The MC "Convective Heat Transfer" will provide the fundamental knowledge of convection heat transfer. Balance equations will be introduced as well as the boundary layer theory on flat plates, within tubes, and under natural convection conditions. The main non-dimensional numbers will be introduced and interpreted from the physical point of view. Differences between laminar and turbulent convection will be discussed. Balance equations for turbulent conditions will be also introduced. Development of simple applications.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Develop balance equations • Calculate relevant non-dimensional numbers • Understand the effect of the boundary layer • Recognize the effect of laminar and turbulent conditions			
Table of contents			
• Conservation equations in laminar conditions. • Introduction of Nusselt number, Prandtl's and Reynold's numbers; Netwon's law of cooling. • Boundary layer on a flat plate and on a tube. • Conservation equations in turbulent conditions. • Natural convection, buoyancy term and Grashov's number			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, 3 hours, on the conservation equation in laminar conditions, boundary layer and conservation equations in turbulent conditions • Presentations, data sheets, worked exercises, teaching aids, and research papers			
Prerequisites			
Knowledge of calculus. Knowledge on thermodynamics and basic heat transfer			
Assessment methods			
Multiple choice questions and solution of written exercises			

MC-P13: Energy markets

MC title	Energy Markets		
MC long title	Understanding the Fundamentals of Energy Market		
ISCED codes	*Primary*: 071	*Complementary*: 031, 041	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
The present MC will support the development of knowledge and skills to understand the dynamics of energy markets. Power, natural gas, and carbon markets will be analysed. The fundamental concepts and basic rules of these three markets, relevant in EU contexts, will be introduced and discussed. The knowledge presented in this MC is relevant since it is transversal to understand the dynamics of the energy sector.			
Overview of the micro-credential			
The MC "Energy Market" will provide an overview of power, natural gas, and carbon markets. The basic principles of each of these markets will be illustrated. The demand and supply balance will be discussed, as well as the concepts of merit order, marginal cost of production, and marginal abatement cost curve. An analytical approach to the description of the markets will be adopted. The connections among the three markets will be also analysed and the reciprocal influences discussed.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Identify the interconnections among power, natural gas, and carbon markets • Understand the main drivers influencing energy markets • Estimate the system marginal price on a power market • Develop quantitative analyses for describing the market trends			
Table of contents			
• Introduction to the demand and supply balance. • Power market: day-ahead price, system marginal price, unit commitment problem, calculation of the variable cost of generation, concept of merit order. • Natural gas market: pricing formulas, gas hubs, take-or-pay clause. • Carbon market: marginal abatement cost curve, impact of carbon market on power generation.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, 3 hours, on the introduction of energy markets, definition of simple KPI for market analysis and concept of marginal abatement cost curves • Presentations, data sheets, worked exercises, teaching aids, and research papers			
Prerequisites			
• Knowledge of the main units of measures used in the energy field. • Basic understanding of the main definitions of macro-economic aggregations (e.g., GDP, value added, etc.).			
Assessment methods			
• Multiple choice questions • Development of a case study based on public data on the analysis of an energy market.			

MC-P14: Case studies in thermal systems

MC title	Case Studies in Thermal Systems		
MC long title	Analysis of Practical Case Studies in Thermal Systems		
ISCED codes	*Primary*: 071	*Complementary*: 041, 061	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
The present MC will support the development of knowledge and skills to analyse practical case studies in thermal systems. The implementation of multidisciplinary methodologies (e.g., energy and finance) is relevant to propose optimal solutions for thermal management of systems. Similarly, the concrete applications of complex methodologies to real cases will allow to develop sophisticated analyses to generate more accurate results.			
Overview of the micro-credential			
The MC "Case Studies in Thermal Systems" will focus on the practical analytical solution of concrete examples related to the thermal management of systems. Optimization of insulation layers, energy efficiency interventions, renewables systems or specific devices (e.g., fins) will be considered as exemplary cases. Minimization/maximization problems will be proposed, numerical methodologies will be employed, and transient system analysed. Calculations will be developed in a spreadsheet tool.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Develop a structured calculation model in spreadsheet format • Analyse complex thermal systems • Compare different solutions and draft conclusions • Apply theoretical knowledge in heat transfer and thermodynamics			
Table of contents			
• Techniques for developing structured calculation spreadsheets, application of min/max functions. • Implementation of simple numerical solutions (e.g., finite volume methods in simple cases) • Probabilistic vs. deterministic solutions. • Dynamic modelling of thermal systems. • Thermo-economic analysis of systems.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, 3 hours, on the solution of concrete case studies • Presentations, data sheets, worked exercises, teaching aids, and research papers			
Prerequisites			
Knowledge of the fundamental laws of thermodynamics and heat transfer.			
Assessment methods			
Multiple choice questions Solution of a realistic case study.			

MC-P15: Basics of investment analysis

MC title	Basics of Investment Analysis		
MC long title	Introduction to the fundamental of Investment Analysis		
ISCED codes	*Primary*: 041	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7
Background of the proposed micro-credential			
The present MC will support the development of knowledge and skills to develop investment analysis. This MC provides a transversal knowledge applicable in many problems connected with RES and energy efficiency. It provides the quantitative decision-making framework for investment decisions and projects development.			
Overview of the micro-credential			
The MC "Basics of Investment Analysis" will provide the basic knowledge related to the development of investment analysis. The concept of time value of money is discussed as well as the definition of discount rate is introduced. Based on these fundamental concepts the main indexes for investment analysis are introduced, namely the Net Present Value (NPV), Internal Rate of Return (IRR), Pay back period (PBP), Discounted Pay Back Period (DPBP), and Profitability Index (PI). Furthermore, considerations related to the risk connected with investments are proposed.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Illustrate the logic for analysing investments • Develop quantitative models for investment analysis • Compare the results of the different indicators • Propose quantitative conclusions			
Table of contents			
• The time value of money: the concept of the discount rate, compounding and discounting operations. • Net present value, internal rate of return; simple pay-back period; discounted pay-back period; profitability index. • The concept of investment risk; sensitivity analysis. • Switching from a deterministic based investment analysis to a probabilistic approach.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, 3 hours, on the definition and illustration of the investment indicators • Presentations, data sheets, worked exercises, teaching aids, and research papers			
Prerequisites			
Knowledge of basic mathematics.			
Assessment methods			
Multiple choice questions Solution of a case study.			

MC-P16: Conduction heat transfer

MC title	Conduction heat transfer		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

The present MC will support the development of knowledge and skills to understand the physics of conduction heat transfer. A rigorous theoretical analysis of the topic will be proposed since it is relevant for all the energy application. The comprehension of conductive phenomena supports the development of innovative applications in the field of renewables and energy efficiency. A precise mathematical and quantitative approach will be pursued in this MC. All the concepts of this MC will be fundamental to understand more applied topics related to specific applications/devices.

Overview of the micro-credential

The MC "Conduction Heat Transfer" will provide the fundamental knowledge of conduction heat transfer. The MC will start from the introduction and derivation of the general heat conduction equation including the discussion of its main hypotheses. The classical transient cases, namely semi-infinite body and lumped capacitance approach will be introduced and derived. Finally, the finite volume method is presented for the numerical solution of conductive problems and the general heat conduction equation for non-isotropic materials is presented.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- Develop the general heat conduction equation
- Calculate the main parameters for heat conduction problems
- Understand the effect of thermal resistance
- Apply numerical methods for the solution of the heat conduction equation

Table of contents

- Derivation of the general heat conduction equation, corresponding boundary conditions and analytical solutions of simple cases.
- Concept of thermal resistance and derivation of the corresponding equations.
- Development of the non-dimensional equation for the one-dimensional transient case and derivation of Biot number.
- Introduction of the lumped capacitance approach for transient solution.
- Introduction of the finite volume method for numerical solutions; general heat conduction equations for non-isotropic materials.

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, 3 hours, on the general heat conduction equations, semi-infinite body, lumped capacitance approach and finite volume method
- Presentations, data sheets, worked exercises, teaching aids, and research papers

Prerequisites

Knowledge of calculus.
Knowledge of thermodynamic and heat transfer.

Assessment methods

Multiple choice questions
Solution of written exercises.

MC-P17: Energy efficiency financing

MC title	Energy Efficiency Financing		
MC long title	Introduction to the main business models for energy efficiency financing		
ISCED codes	*Primary*: 041	*Complementary*: 071	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
The present MC will support the development of knowledge and skills related to the main schemes supporting the development of investments in energy efficiency. Since energy efficiency is an immaterial good, often difficult to estimate, classical investment models are not suitable and innovative instruments are necessary. Usually, these instruments are operated through Energy Saving Companies (ESCOs) or by developing other innovative schemes which can be commercial or public based (e.g., on-bill schemes or on-tax financing).			
Overview of the micro-credential			
The MC "Energy Efficiency Financing" will provide an overview of the most relevant investment schemes supporting energy efficiency. Classical models applied by ESCOs, such as Energy Performance Contracts (EPCs), Energy Service Agreements (ESAs) and Managed Energy Service Agreements (MESAs) will be illustrated and discussed. Furthermore, innovative approach such as on-bill schemes and on-tax approaches will be proposed. The aim is to provide the knowledge of the main available financial agreements for implementing energy efficiency investments. Pros and Cons of the different solutions will be discussed.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Identify the most suitable financial agreement according to the measures to be developed • Compare the main features of the proposed financing models • Recognize the implications on the project due to different agreements			
Table of contents			
• Introduction to the problem of energy efficiency financing. • Risks connected with energy efficiency investments. • Energy Performance Contracts. • Energy Service Agreements and Managed Energy Service Agreements. • On-Bill Schemes; on-tax schemes.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, 3 hours, on the definition the different financing schemes • Presentations, data sheets, worked exercises, teaching aids, and research papers			
Prerequisites			
Knowledge of the main units of measures used in the energy field. Basic understanding of the main definitions of macro-economic aggregations (e.g., GDP, value added, etc.).			
Assessment methods			
Multiple choice questions Development of a case study based on real data from public databases such as Eurostat.			

MC-P18: Heat transfer in buildings

MC title	Energy Efficiency Financing		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 072, 073	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
The present MC will support the development of knowledge and skills to understand the physics of heat transfer in buildings. A rigorous theoretical analysis of the topic will be proposed since it is relevant for energy efficiency applications in buildings. The comprehension of heat transfer mechanisms from the building envelope supports the development of innovative applications in the field of energy efficiency. A precise mathematical and quantitative approach will be pursued in this MC. All the concepts of this MC will be fundamental to understand more applied topics related to specific applications/devices.			
Overview of the micro-credential			
The MC "Heat Transfer in Buildings" will provide the fundamental knowledge to estimate the thermal load of a building. The thermal load of a building is the starting point for designing energy efficiency measures and for integrating possible renewable solutions. The MC will start from the modelling of the heat transfer from a generic building wall. The effect of conduction, convection and radiation heat transfer will be illustrated, and the relevant equations introduced. Thermal balances for winter and summer conditions will be presented. Finally, Life Cycle Analysis considerations will be proposed.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Develop the thermal balance for a building wall • Calculate the thermal load of a buildings • Understand the trade-off between a static and a dynamic approach • Propose effective solutions for enhancing energy efficiency			
Table of contents			
• Derivation of the resistance network for a generic building wall. • Development and solution of the thermal balance of generic building wall. • Definition of thermal bridge, linear transmission coefficient for the estimation of thermal bridges. • Estimation of the average conductance of a window. • Introduction to Life Cycle Analysis.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, 3 hours, on the definition the different financing schemes • Presentations, data sheets, worked exercises, teaching aids, and research papers			
Prerequisites			
Knowledge of calculus. Knowledge of thermodynamic and heat transfer.			
Assessment methods			
Multiple choice questions. Solution of a written exercise.			

MC-P19: Energy utilisation and storage

MC title	Energy Utilization and Storage		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 041, 061	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6-7-8

Background of the proposed micro-credential

To achieve the emission reduction targets set by the European Union, it is necessary to phase out fossil fuels and accelerate the energy transition towards an energy system based on renewable energy sources. Energy storage and active management of local resources play a key role in this transition to a carbon-neutral economy as critical tools to facilitate the integration of variable renewable energy sources. Therefore, it is essential to empower professionals with skills in energy storage technologies and demand-side management that help enhance the integration of renewable energy sources.

Overview of the micro-credential

The aim of this MC is to increase the awareness of the participants on the relevance of local energy resources management and storage capabilities as tools to accommodate higher levels of local generation based on variable renewable sources and, at the same time, to facilitate the accommodation of higher levels of demand arising, for example, form the electrification of the transportation sector. The possible double role of storage equipment, static batteries or electric vehicles, is challenging and, at the same time, provides many opportunities in the energy transition process.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- adequately characterize energy needs and availability, as well as optimization measures
- discuss the multiple alternatives to supply the local energy needs
- assess and evaluate alternative consumption patterns through demand-side management
- evaluate the role of storage in meeting energy needs
- characterize the alternative functions/roles of the storage facilities/equipment: energy and flexibility

Table of contents

- Energy consumption and energy supply alternatives and availability in urban environments.
- Local energy networks.
- Electrification strategies: the main challenges.
- Demand-side management.
- Energy management algorithms.
- Storage and EVs as flexibility, energy and ancillary services providers.
- Energy storage business models.

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, presentations and worked exercises.

Prerequisites

Basic notions of energy consumption and unit measures used in the energy field.

Assessment methods

Multiple choice questions.
Discussion of practical examples.

MC-P20: Energy consumption characterisation

MC title	Energy consumption characterisation		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*:	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6-7-8

Background of the proposed micro-credential

Given the complexity of today's energy consumption and energy dependency, it is essential to be able to monitor energy consumption and properly analyse and understand the measurements. Monitoring systems and energy audits are technologies and tools necessary for characterizing the energy consumption of end uses, equipment, processes, buildings, and cities, allowing the identification of potential energy efficiency measures and opportunities for integrating renewable energy solutions. The adequate characterization of the conditions of the energy utilization and the availability of energy production is critical for identifying energy optimization opportunities and, at the same time, facilitating the dissemination of variable renewable sources. Also, an adequate knowledge of the different stakeholders' needs, preferences, constraints and objectives is essential.

Overview of the micro-credential

The aim of this module is to provide methodological approaches and tools for a comprehensive characterization of energy consumption and local generation availability as pillars for the identification of energy optimization measures. To this end, energy consumption and the efficient use of energy will be the focus of analysis, evaluating the barriers hindering and drivers enhancing this efficient use, as well as energy audits to improve it through the identification of energy optimization measures. Furthermore, the key performance indicators most used to analyse demand/load diagrams and to perform benchmarking processes will be addressed.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- be aware of the need and usefulness of energy audits as a tool for promoting optimized use of energy
- know the distinct phases that makeup energy audits and the required equipment.
- adequately characterize consumption and generation profiles and the associated indexes or indicators.
- identify and characterize energy optimization measures.

Table of contents

- Introductory concepts regarding energy consumption in cities
- Demand/load diagrams and generation availability
- Efficient use of energy, drivers and barriers
- Energy tariffs
- Energy audits
- Characterization of energy optimization measures
- Energy benchmarking: key performance indicators

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, presentations and worked exercises.
- Practical examples on real data

Prerequisites

Basic knowledge of energy concepts and units.

Assessment methods

Multiple choice questions.

MC-P21: Thermal simulation of buildings

MC title	Thermal simulation of buildings		
MC long title	Introduction to thermal characterization and energy simulation of buildings		
ISCED codes	*Primary*: 071	*Complementary*: 061, 073	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6-7
Background of the proposed micro-credential			
To achieve the established long-term climate neutrality targets, the Energy Performance of Buildings Directive was revised to set a more ambitious goal that from 2027 all new public buildings, 2030 all new buildings and from 2050 all buildings should be zero-emission buildings (ZEB). This goal of ZEB calls for buildings to have very high performance, with a very low amount of energy required being covered by energy from renewable sources and no on-site carbon emissions from fossil fuels. Given the need to improve the energy performance of the building stock, building energy simulation becomes an essential tool to help achieve these goals. Therefore, it is fundamental to train and empower professionals with skills in building energy simulation programs to be able to face the challenges currently posed.		
Overview of the micro-credential			
The aim of this MC is to introduce the students to the building energy simulation tools, showing their capabilities for the design of new and renovated buildings. This MC will provide the procedures to define the geometry of a building model, the parameterization of the thermal properties of the envelope and building utilization. The development of the exercises will permit to understand the capabilities to obtain detailed and integrated results about the different heat exchanges and thermal loads of a building system. The development of a case study will be used to practice and compare the influence of different solutions on the thermal performance of buildings. At the end, students will be prepared to use building simulation tools to contribute for the design of highly efficient buildings.		
Learning objectives			
On the completion of the micro-credential, participants will be able to: • consolidate the main theoretical foundations and calculation methodology of building energy simulation. • acquire the procedures and good practices for the adequate and effective use of building energy simulation tools. • develop and consolidate skills to apply the general criteria for the definition and parameterization of building models and perform critical analysis of the results. • evaluate the impact of building renovation measures.		
Table of contents			
• Introduction to thermal simulation of building. • Introduction to the adopted simulation program: EnergyPlus. • Geometry definition of a building model. • Thermophysical parameterisation of materials and construction elements, definition of internal gains, air infiltration and ventilation, weather data and simulation parameters. • Result analysis.		
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures to introduce the thermal simulation of buildings (2 hours) • Presentations, worked exercises, and tutorial support for the development of case studies		
Prerequisites			
Basic knowledge of thermodynamics and heat transfer.			
Assessment methods			
Multiple choice questions. Written case study report.			

MC-P22: Advanced modelling of buildings and energy systems

MC title	Advanced modelling of buildings and energy systems		
MC long title	Advanced modelling of buildings and energy systems: the BIM approach		
ISCED codes	*Primary*: 071	*Complementary*: 061, 073	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

In the building sector, which encompasses architecture, engineering, construction and operation and maintenance, among other activities, digitization is established by Building Information Modelling (BIM). In the design phase, the BIM methodology allows the integrated three-dimensional visualization of the architectural project and the different technical disciplines, facilitating the communication, the identification of incompatibilities and the performance analysis of alternatives, namely thermal, energetic, and environmental, through the capabilities of the built-in calculation programs. Also, the BIM methodology allows the database of a building created in the design phase be used and kept updated in all the following phases of the building's lifecycle (construction, operation, maintenance, renovation or rehabilitation and end of life). Thus, it is important to push the training and use of the BIM methodology, which will offer great potential to support the achievement of the current objectives of decarbonizing the buildings sector.

Overview of the micro-credential

The aim of this MC is to introduce the use of the BIM methodology, focusing on the energy modelling of buildings, Heating, Ventilating and Air-Conditioning (HVAC) systems, and renewable energy systems integration. Based on a BIM environment platform the students will be trained to use different tools for 3D representation and calculation procedure (architectural building model, thermal loads calculations, HVAC and energy systems 3D representation and dimensioning). The learning process will be developed in groups of 2/3 students, who will be challenged to learn and use different technological tools to study and design highly efficient case studies buildings projects. Beyond the training of the BIM methodology and technological design tools, this MC intends to help the development of the critical thinking, creativity and collaboration work.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- be familiar with the BIM methodology and its capabilities;
- be prepared to use HVAC and energy systems technological tools to design highly efficient buildings, and integration of renewable energy systems;
- develop critical thinking, creativity and acquire the procedures and good practices to develop projects in a collaboration context;

Table of contents

- Introduction to BIM methodology and software packages.
- Characterization and 3D geometric model of a case study building.
- Parameterization of the building model and thermal loads calculation.
- Design and sizing of HVAC systems and renewable energy systems.
- Performance evaluation and improvement studies.

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures to introduce a BIM Platform and software package (2 hours)
- Software Packages tutorials and tutorial support for the development of case studies

Prerequisites

Basic knowledge of thermodynamics and heat transfer.
Fundamentals of thermal characterization and energy modelling of buildings and CAD tools

Assessment methods

Multiple choice questions.
Written case study report.

MC-P23: Energy strategy and energy transition

MC title	Energy strategy and energy transition		
MC long title	Advanced modelling of buildings and energy systems: the BIM approach		
ISCED codes	*Primary*: 041	*Complementary*: 052, 071	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7

Background of the proposed micro-credential

To achieve the ambitious goal of carbon neutrality by 2050 will require not only a focus on energy efficiency to reduce current energy needs, but also a strong commitment to renewable energy sources. These goals will require profound changes in all sectors of society (e.g., industry, buildings, transportation, and agriculture) and in the energy policies that govern countries, thus creating several challenges that will need to be addressed. Nevertheless, unique opportunities will also be created that will lead to new services and business models. This course provides information on the technical and societal challenges and opportunities for a sustainable energy transition.

Overview of the micro-credential

The aim of this module is to provide fundamentals on new possible local business models including RES through enabling technologies. To do so, it will address technical innovations and methods to decarbonize the power generation sector, while analysing the effects and main challenges of a high proportion of renewable energy in the power system, such as security of supply, reliability, and resilience. Furthermore, non-technical innovations, such as social, markets, political, and regulatory, will also be addressed.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- Characterise the technical possibilities for decarbonizing the energy and end-user sectors.
- Recognize and assess innovations that go beyond technological solutions for a sustainable transition.
- Discuss the main challenges raised by the energy transition process, namely due to the massive dissemination of generation based on renewable sources and the increasing demand resulting from electrification of our societies.
- Discuss the different tools and approaches to deal with the energy transition process

Table of contents

- Technical innovations and methods to decarbonize the energy production sector.
- Integration of a high proportion of renewable energy into the power system.
- Energy usage, with a focus on how to decarbonize the end-use sectors.
- Non-technical innovations.
- Renewable power systems: main challenges, security of supply, reliability, and resilience

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, data sheets, presentations, and discussion of research papers

Prerequisites

None

Assessment methods

Multiple choice questions.
Written assignment with oral presentation.

MC-P24: Energy management and smart communities

MC title	Energy management and smart communities		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 031	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

To facilitate the dissemination of local generation based on variable renewable energy sources and the electrification of our societies, two pillars of the energy transition, the active management of all available resources is critical. Community energy production should preferably be used locally, requiring local management and energy transactions. As resource management facilitates the dissemination of local generation, a deep understanding of existing dynamics between generation and consumption at local level and a thorough knowledge of its optimisation issues are required. Some aggregation at the resource management level enormously benefits the dissemination of variable renewable sources and the local utilization of the local generation. Concepts such as energy communities and microgrids are at stake, and tools such as demand-side management activities will play a critical role. Energy communities will reshape the traditional electricity system, and the active participation of citizens will accelerate the energy transition process.

Overview of the micro-credential

This module aims to increase the participant's awareness of the relevance of local/community energy generation and the usefulness of active management of energy resources. Different forms of aggregation and sharing local generation will be discussed. Participants must acquire in-depth knowledge of community energy production and sharing challenges. The legal framework will be at the debate, and the role of energy communities, nano/microgrids and virtual-power plants in the energy transition process will be discussed.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- able to clearly understand the role of dispersed generation in the energy transition process and the need for active management of different resources (generating units, controllable demand, storage);
- able to understand the concepts and the roles of energy communities, microgrids and virtual power plants in the overall transition process;
- aware of the main objectives, constraints, technical requirements and consumer preferences that are at stake in energy management activities at different aggregation levels: individual consumers, buildings, communities, and cities/regions;
- aware of the main challenges, barriers and drivers for local transactions of energy.

Table of contents

- Introductory concepts about energy conversion: local generation, demand, storage, and flexibility.
- DSM: concept, evolution, barriers and cost-benefit analysis.
- Energy communities, microgrids, and virtual power plants: definition of concepts, legal framework, drivers and challenges.
- Resources management: individual level and aggregate level.
- Local transactions of energy.

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, presentations, and discussion of research papers
- Case studies

Prerequisites

Basics energy concepts

Assessment methods

Multiple choice questions.

MC-P25: Sustainable development

MC title	Sustainable development		
MC long title	-		
ISCED codes	*Primary*: 031	*Complementary*: 041, 052, 071, 072	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7-8
Background of the proposed micro-credential			
Sustainable development of society requires concerted efforts that harmonize economic growth with social inclusion and environmental protection. To achieve a better and more sustainable future for all, the United Nations' sustainable development goals were set to address the today's challenges, which include, for example, poverty, inequality, environmental degradation, and climate change. The goal of this module is to provide interdisciplinary information about the United Nations' sustainable development goals (SDGs) and to provide understanding of how RES and RFT impact these SDGs.			
Overview of the micro-credential			
This course introduces students to the interdisciplinary field of sustainable development, drawing on the most recent advances in social, policy, and economic sciences. It describes the intricate interactions between the global economy and the issues of environmentally sustainable and socially inclusive development. By the end of this course, students will have a broad understanding of the key challenges and potential solutions to achieving sustainable development in the twenty-first century.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Understand the definitions of sustainable development, MDGs, and SDGs. • Discover how RES and RFT affect SDGs. • Address the issues of sustainable development • Understand the primary political and economic mechanisms associated to SD.			
Table of contents			
• Introduction to sustainable development. • Agenda 2030: From the Millennium Development Goals to the Sustainable Development Goals • Economic, energy, environmental, and societal consequences • Climate Change Mitigation: Political and Economic Instruments • Global and Urban Sustainability • ESG Fundamentals for Sustainable Business Practices			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, presentations, and discussion of research papers			
Prerequisites			
None			
Assessment methods			
Multiple choice questions.			

MC-P26: Energy policy

MC title	Energy policy		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 052, 071, 072	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7-8
Background of the proposed micro-credential			
Given the goal of achieving carbon neutrality by 2050 and the current energy crisis plaguing the European Union, defining appropriate energy policies to address current challenges and achieve the established targets is increasingly essential. These policies should address in a concerted manner all economic sectors and parts of society, including for example industry, buildings, and agriculture, as all will play an important role. The aim of this module is to provide an understanding of the development of EU energy policy, namely the climate and RES directives, and the current challenges to meeting the 2050 climate neutrality objective.			
Overview of the micro-credential			
Acquaint students with energy policy and economic concepts, both in analytical and modelling terms. Promote research skills in frontier areas as "economy-business-engineering". Promote awareness of policy and decision-making processes affecting energy management and development in both government and industry, including the economic, policy, regulatory, and institutional drivers that shape management decisions.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • Understand how energy and climate change policies are designed and implemented. • Understand the importance of regulation. • Understand climate change, ensuring economic development, fighting inequality, managing the rapid transition to renewable energy. • Develop policy analyses and guidelines in a wide range of energy-related areas.			
Table of contents			
• Energy policy and climate governance of the European Union (EU). • Energy value chain economics • structure of energy demand and supply. • Sectoral regulation policies • Electricity market reforms and competition in the electricity industry • Market power, an energy crisis, security of supply, market failures, and externalities • Renewable energy: policy incentives			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, presentations, and discussion of research papers			
Prerequisites			
Basics of microeconomics			
Assessment methods			
Multiple choice questions.			

MC-P27: Thermal energy storage

MC title	Thermal energy storage		
MC long title	Introduction to thermal energy storage systems		
ISCED codes	*Primary*: 071	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6-7
Background of the proposed micro-credential			
Energy storage systems are one of the options to help address the current energy challenges, as their use can bridge the gap between energy needs and availability in various applications and at various times. In short, energy storage makes it possible to cope with the variations in energy supply caused by the intermittency of renewable sources. To enhance the integration of renewable energy solutions and maximize the renewable energy capture it is essential to increase the knowledge of existing thermal energy storage technologies and solutions among professionals in different sectors.			
Overview of the micro-credential			
The aim of this MC is to describe the several technologies of energy storage and their integration with renewable energy solutions, to maximize renewable energy capture. To this end, it will provide an overview of the thermal energy storage solutions available on the market, how to interconnect them with the existing renewable systems and use of thermal energy, and how to integrate them in urban environments. Characteristics (e.g., working principles, storage capacity, performance, cost) of thermal energy storage technologies and types of systems will be introduced and analysed. Furthermore, it will be assessed how these characteristics may influence their adoption in certain situations and applications.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • acknowledge the various thermal energy storage solutions available on the market and their potential applications. • compare the different existing thermal energy storage solutions. • identify and suggest energy storage solutions that enable the integration of renewable energy solutions in specific situations.			
Table of contents			
• Heating and cooling needs in buildings and industry. • Overview of renewable thermal energy waste heat recovery technologies. • Thermal energy storage technologies: classification, working principles, storage capacities. • Economic aspects of thermal energy storage systems.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, presentations, and discussion of research papers			
Prerequisites			
Basics notions on thermodynamics, fluid mechanics and heat transfer			
Assessment methods			
Multiple choice questions.			

MC-P28: Decarbonisation of thermal energy

MC title	Decarbonisation of thermal energy		
MC long title	Decarbonisation of thermal energy in urban environment		
ISCED codes	*Primary*: 071	*Complementary*: 073	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
Space heating, cooling and hot water are essential end-uses contributing to cities' global final energy consumption. This MC will focus on decarbonising these energy demands, mainly through electrification. Learners will understand the relevance of thermal demand for cities and the climate goals that the EU green deal established on this topic. First, we will assess the current state of the existing technology employed in the cities to face the issue. Then, we will explore the alternatives available to decarbonise the thermal demand in urban areas.			
Overview of the micro-credential			
The MC will focus on decarbonising thermal energy demands, mainly through electrification. First, it will provide an overview of the relevance of thermal energy in the cities' carbon footprint. Next, we will highlight this sector's EU Green Deal climate targets. The following topic will assess the existing thermal energy systems for heating, cooling and DHW in European cities. Ultimately, the MC will provide the skills for designing alternative technologies for achieving a carbon-neutral city. These alternatives involve solar collectors for DHW, heat pumps for heating and cooling, biomass boilers and hybrid systems, including storage.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • understand the relevance and challenges of decarbonising urban thermal demands • size solar DHW installations • size heat pumps installations for residential heating and cooling • size biomass boilers at a residential scale • design basic hybrid systems involving storage			
Table of contents			

• EU Green Deal climate targets for thermal urban decarbonisation
• Existing thermal energy systems for heating, cooling and DHW in cities
• Alternative technologies to decarbonise thermal energy systems in cities:
  ○ Design and sizing of solar DHW installations
  ○ Heat pumps systems for residential heating and cooling
  ○ Design and sizing of geothermal heat pumps
  ○ Biomass boiler for the residential scale
  ○ Hybrid systems, including storage or PV generation			

Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, 4 hours, on the relevance of thermal energy needs, EU green deal climate targets and existing thermal energy systems. • Presentations, data sheets, worked exercises, teaching aids, and research papers			
Prerequisites			
Basics notions on mathematics and physics at EQF 5-6			
Assessment methods			
Multiple choice questions.			

MC-P29: Efficient building techniques

MC title	Efficient building techniques		
MC long title	Efficient building techniques evaluation and bioclimatic design		
ISCED codes	*Primary*: 073	*Complementary*: 071, 072	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6-7

Background of the proposed micro-credential

Buildings contribute to overall energy consumption is quantified at 30-40%, depending on their use and location. Due to its specific characteristics, it is one of the sectors in which the European Community recognises one of the most significant energy savings potentials. The MC tries to impact this issue by presenting the most representative and currently recognised technologies in achieving buildings with minimum energy consumption. It will start by assessing the current thermal performance of buildings and the principles of construction standards. Following, the MC will present the most used methods to evaluate the thermal performance of a building. Finally, we will work on innovative technologies and materials to improve buildings' efficiency.

Overview of the micro-credential

The MC presents the most recognised technologies in achieving buildings with minimum energy consumption. First, we will study the thermal performance of a building and discuss the basic principles of sustainable buildings from a thermal perspective. Following, we will present students with minimum energy consumption standards like Passivhaus. The next phase of the MC will involve ways to measure buildings' thermal performance. Infrared thermography is a powerful method to evaluate thermal isolation. The blower door testing evaluates construction infiltrations. Finally, building modelling and simulation improve technicians' understanding of building energy performance. To conclude the MC, learners will study innovative solutions in building construction. Geothermal energy is a heat pump-based system to heat and cool spaces with high efficiency, and bioclimatic design considers the environmental context to shape the construction.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- understand the basic principles of sustainable buildings from an energy point of view.
- diagnose the thermal performance of a building.
- design buildings with minimum energy consumption.

Table of contents

- Introduction to the thermal performance of buildings
- Basic principles of sustainable building
- Minimum energy consumption standards. Example: Passivhaus
- Infrared thermography applied to building construction.
- Infiltrations and Blower door testing
- Building modelling and simulation
- Geothermal energy and bioclimatic design

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, 6 hours, on the study of the thermal performance of buildings, minimum energy consumption standards, diagnosis of building thermal performance and principles of bioclimatic design.
- Presentations, data sheets, worked exercises, teaching aids, and research papers

Prerequisites

Basics notions on mathematics and physics at EQF 5

Assessment methods

Multiple choice questions.

MC-P30: Electric storage systems

MC title	Electric storage systems		
MC long title	The role of energy storage for flexible electricity systems		
ISCED codes	*Primary*: 072	*Complementary*: 071	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

In recent years the electricity system has started to undergo significant changes. Recent developments in the electricity system have raised calls for additional storage capacities. These developments involve digitalisation, variable renewable energy sources and decentralisation of generation. This MC's core objective is to examine the role of electricity storage in such smart energy systems. For that, learners will learn about the relevance of storing energy in innovative systems, the different technologies available to store electricity and how to select the most appropriate of them.

Overview of the micro-credential

The main goal of this MC is to exploit the potential electricity storage in innovative energy systems. Learners will be introduced to the topic by an overview of the relevance of storage systems. Thus, we will explore alternatives to store electricity using different technologies. The MC will consider electrochemical, thermal, chemical and mechanical storage options. Students will learn these alternatives from a practical standpoint to teach them how to design and size different storage systems. During the course, we will assess topics such as seasonal storage, materials and hydrogen potential. Once we have considered all alternatives, students will learn how to evaluate the most effective storage alternatives for decarbonising urban environments.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- understand the need for storage in energy systems
- identify the storage alternatives and assess their main features
- select the most appropriate storage alternative for designing an energy system
- design and size storage systems for flexibility and demand response strategies

Table of contents

- Relevance of storage on the energy system
- Electrochemical storage
- Thermal storage of electricity
- Chemical storage of electricity: the case of hydrogen
- Mechanical storage of electricity
- Evaluating the most appropriate storing technology

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, 6 hours, on the relevance of energy storage, storage alternatives and their evaluation.
- Presentations, data sheets, worked exercises, teaching aids, and research papers

Prerequisites

Basics notions on mathematics and physics at EQF 5-6

Assessment methods

Multiple choice questions.

MC-P31: Energy communities

MC title	Energy communities		
MC long title	Energy communities: implementation in the urban environment		
ISCED codes	*Primary*: 071	*Complementary*: 031	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7
Background of the proposed micro-credential			
Local energy communities (LEC) will be an essential cornerstone for the success of the Energy Transition, especially for urban areas where people live in apartment blocks with no access to privative roofs. The European Union (EU) acknowledges in the "Clean Energy for all Europeans" package the need for empowering prosumers to generate, consume, store, and sell electricity back to the grid. Thus, the EU introduces the notion of renewable energy communities (REC). Interest in LECs arises from the various benefits the concept of LEC presents from various perspectives, such as environmental, social, economic and technical. This MC will give learners an understanding of the concept and its regulative implications in the EU. The course will teach how to establish a new LEC and explore ways to upscale them for large-scale urban decarbonisation.			
Overview of the micro-credential			
This MC aims to give learners a good understanding of the local energy community (LEC) concept, its potential for a systematic change in the energy system and how to implement them. The MC will start by explaining the concept of LEC and its relevance in the urban context. Following this, we will set the European legal framework for LECs, explaining the similarities and differences between the Citizen Energy Communities and the Renewable Energy Communities. From here, we will explore the status of energy communities in the EU and some success stories to highlight the implications for the region and the energy system. Once they have performed this exercise, they will learn how to establish a LEC. Finally, we will discuss the possibilities of upscaling and interconnecting energy communities to decarbonise larger areas of the city.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • understand the concept and implications of local energy communities. • establish a new local energy community following basic guidelines. • upscale and interconnect the communities			
Table of contents			
• Concept and relevance of energy communities • European legislation: Citizen Energy Communities vs Renewable Energy Communities • Current status and development of local energy communities (LEC) • LECs' impact and benefits: technical, economic, environmental and social aspects. • Main barriers and challenges • LEC establishing process. • Upscaling and interconnecting communities to decarbonise cities			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, 4 hours, on the concept and regulation of energy communities, the local energy communities impact, benefits and barriers and the establishing process guidelines. • Presentations, data sheets, case studies, teaching aids, and research papers			
Prerequisites			
Basics knowledge of the energy systems. Fundamental understanding of the energy market.			
Assessment methods			
Multiple choice questions.			

MC-P32: Fuel poverty solutions

MC title	Fuel poverty solutions		
MC long title	Fuel poverty solutions for a just and inclusive urban decarbonisation		
ISCED codes	*Primary*: 031	*Complementary*: 041, 071	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6-7

Background of the proposed micro-credential

A household is in fuel poverty when its inhabitants are left with a residual income below the official poverty line if they spend what is required to achieve thermal comfort. Fuel poverty is a global problem accentuated in Europe due to the economic crisis. It has given rise to government and political party interest and has caused a significant public impact. However, European member states have not established an official standard to assess fuel poverty. Therefore, certain countries do not recognise this type of poverty as a social problem. Thus, this MC will be relevant to the understanding or, in some cases, the discovery of fuel poverty to students. The focus of this MC is not just on the concept but on the solutions. Hence, we will explore actions to tackle fuel poverty from different perspectives, such as inefficient housing, self-consumption strategies, changes in the energy system, or user behaviour.

Overview of the micro-credential

This MC aims to give actionable solutions for the students to tackle fuel poverty. It will start by defining fuel poverty and the estimated impact in Europe. This part of the MC will include an assessment of the effect of medium- and long-term exposure to inappropriate temperatures and humidity in summer and winter. The MC will then focus on exploring the possible solutions to this issue. First, learners will assess economic solutions to fuel poverty. Second, they will consider retrofitting and efficiency enhancement of houses and systems as a solution. Third, the MC will put forward systematic solutions like energy communities, public trading companies and disconnection prevention. Finally, they will reflect on behavioural aspects of energy to reduce fuel poverty.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- understand fuel poverty (FP) and when a dwelling is in fuel poverty.
- know the main solutions to avoid or alleviate fuel poverty.
- estimate the impact on FP of renewable energies in the urban environment.
- propose policies and projects for integrating renewable energies in the city, including families in FP, solving or alleviating their situation, thus promoting a just energy transition.

Table of contents

- Fuel poverty definition and health consequences
- Assessment of economic solutions
- Energy rehabilitation of houses and systems
- Renewable energy self-consumption strategies
- Systematic solutions: energy communities, public energy trading companies and disconnection prevention
- Behavioural aspects: understating the bills and cultivating good habits

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, 4 hours, on the fuel poverty issue and the possible solutions available.
- Presentations, work exercises, case studies, teaching aids, and research papers

Prerequisites

Basics knowledge of the energy systems.

Assessment methods

Multiple choice questions.

MC-P33: Nature-based solutions

MC title	Nature-based solutions		
MC long title	Nature-based solutions in the urban environment		
ISCED codes	*Primary*: 073	*Complementary*: 052, 072	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7

Background of the proposed micro-credential

Nature-based solutions promoting green and blue urban areas have immense potential to reduce vulnerability and enhance cities' resilience to climate change. By incorporating parks, urban forests, wetlands, and natural water bodies, these solutions act as carbon sinks, purify the air, support biodiversity, and mitigate extreme weather events like flooding and storms. Implementing green infrastructure and sustainable urban designs further improves adaptability. Besides environmental benefits, these solutions positively impact public health and well-being, fostering a sense of community and reducing stress among urban dwellers. Moreover, they promote social equity by offering equal access to green spaces and environmental benefits for all residents.

Overview of the micro-credential

This MC will show learners the potential of NBS in urban areas to tackle issues like the heat island effect, pollution, promoting biodiversity or improving surface runoff. Learners will also learn how to implement these solutions effectively, considering the challenges and barriers they pose. First, the MC will describe NBS, its role in cities, and the heat island issue. Then, the MC will explore the impacts of NBS in mitigating and adapting to climate change in the built environment. We will focus on decarbonisation with impacts such as urban heat stress reduction and GHG sequestration. The MC will support these impacts with empirical results from a pilot installation of green roofs and walls. Once the potential is understood, students will learn how to implement NBS in the built environment and which challenges and barriers these actions face.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- understand the concept and impact of nature-based solutions
- understand the heat island issue in the urban environments
- integrate nature-based in the built environment
- cope with the challenges and barriers of integrating nature-based solutions in the cities

Table of contents

- Understanding nature-based solutions
- The heat island effect of the cities
- Impact of NBS on adaptation and mitigation of climate change
  - Evaluation of urban heat stress reduction
  - GHG sequestration and storage
  - Pilot results about GHG savings using NBS
- NBS integration in the built environment
- NBS challenges and barriers

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, 5 hours, on the concept of NBS, the heat island effect, the impact of NBS in the built environment and the challenges to coping.
- Presentations, data sheets, work exercises, case studies, teaching aids, and research papers

Prerequisites

Basics knowledge of urban systems.

Assessment methods

Multiple choice questions.

MC-P34: Positive energy districts

MC title	Positive energy districts		
MC long title	The role of positive energy districts in a fair urban transition		
ISCED codes	*Primary*: 071	*Complementary*: 031, 073	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

Positive Energy Districts (PEDs) are a new paradigm for the energy transition, with an ambitious timetable for rapid upscaling to match the urgency of tackling climate change and adapting to it. PEDs can cut the urban energy transition into pieces according to the different realities that each area of the city experience. This approach allows decarbonisation to take a bottom-up approach to ensure it is fair and no one is left behind. The MC will explain the role of PEDs in a fair energy transition. Learners will get in contact with different indicators that can help measure the performance of the solutions put in place. Following, they will explore how to implement solutions for decarbonising mobility, efficiency and energy demand in urban districts to achieve a fair transition.

Overview of the micro-credential

Positive Energy Districts (PEDs) approach can cut the urban energy transition into pieces to take a bottom-up approach, ensuring it is fair and no one is left behind. The MC will start with an overview of current urban energy transition trends. Next, the MC will explore the design of fair urban energy transitions employing PEDs. Following, learners will explore the role of PEDs in a fair energy transition. To measure success, we need to use appropriate key performance indicators, and the MC will introduce students to the main proposals in the literature. Urban energy transition must confront the sectors with a greater carbon footprint to achieve a carbon-neutral city. This MC will deepen into the mobility problems in cities, building stock lack of efficiency and the thermal and electrical energy demands decarbonisation.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- understanding the convenience of PEDs for urban energy transitions
- know the key performance indicators used to characterise PEDs
- design actions to tackle the primary sources of GHG emissions in an urban area

Table of contents

- Urban energy transitions: an overview
- Designing a fair urban energy transition
- Positive energy district (PED) as a fair approach
- Key performance indicators to characterise a PED
- Tackling mobility and enhancing efficiency
- Decarbonising energy demand
  - Renewable energy generation
  - District heating and cooling
- Energy communities

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, 4 hours, on the role of PEDs to decarbonise cities, key performance indicators and solutions to reduce carbon emissions.
- Presentations, data sheets, case studies, work exercises, teaching aids, and research papers

Prerequisites

Basics on mathematics and physics at EQF 5-6
Basic knowledge on energy systems

Assessment methods

Multiple choice questions.

MC-P35: Smart energy systems

MC title	Smart energy systems		
MC long title	Smart energy systems in urban areas for flexibility and demand response strategies		
ISCED codes	*Primary*: 071	*Complementary*: 061	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

Electrical grids are a fundamental element for energy use. Carbon-neutral cities will have smart energy systems within their territory to generate, store and operate the energy to cover the city demand. Microgrids are proposed in the course as an alternative to achieve the integration of distributed renewable sources and loads or consumers. In addition, energy storage systems are also integrated as backups to make the grid more reliable, take advantage of the excess energy produced by renewables appropriately, and ensure a balance between generation and demand. Learners must understand innovative energy systems and microgrids to implement and operate the required infrastructures while decarbonising cities. This MC will give an overview of what electrical distribution networks are, the elements that make them up and their forms of operation. We will also deal with the reliability of the networks and the energetic improvement of their operation.

Overview of the micro-credential

To implement and run the necessary infrastructures while decarbonising cities, learners must have a solid understanding of innovative energy systems and microgrids. This MC will give an overview of what electrical distribution networks are, the elements that make them up and their forms of operation. We will also deal with the system's energy efficiency and how to improve it. Nonetheless, it is fundamental to maintain the quality of service and power for the users. The grids will get smarter as TICs implementation gets more usual and extensive. Therefore, learners will understand the concept of smart grids and the implications it brings to selecting components and control systems. Finally, this MC suggests microgrids as substitutes for the conventional electricity grid to integrate distributed renewable sources and loads or consumers.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- comprehend the distribution of the electrical power system
- improve the efficiency and quality of service of the electrical distribution system
- make basic designs of a smart grid and an urban microgrid

Table of contents

- Distribution in the electrical power system (elements, loads and renewable generation sources)
- Energy losses and efficiency improvement
- Quality of service and power quality.
- Smart grids: concept, components, and challenges.
- Microgrids in the urban environment.

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, 6 hours, on the distribution of the electrical power system, improving efficiency and quality of service and smart grids.
- Presentations, data sheets, case studies, work exercises, teaching aids, and research papers

Prerequisites

Basics on mathematics and physics at EQF 5-6

Assessment methods

Multiple choice questions.

MC-P36: Tools for city decarbonisation

MC title	Tools for cities' decarbonisation		
MC long title	Tools for cities' decarbonisation: from assessing to planning		
ISCED codes	*Primary*: 061	*Complementary*: 031, 052, 071, 073	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

Decarbonising cities is a complex process that needs broad perspectives and methods. This MC aims to give learners valuable tools to decarbonise any city from a more general scope to a specific result. The MC will teach how to use a multilevel perspective to assess an energy system. More on-the-ground approaches follow this assessment, such as solution concept mapping, stakeholders analysis, results reporting and mapping the results in GIS (such as ArcGIS or QGIS). Thus, we move on to prioritising the solutions using multicriteria decision methods. The solution will probably respond to multiple objectives, and multi-objective optimisation methods will help achieve carbon-neutral cities. Finally, the MC combines all these tools in developing decarbonisation roadmaps.

Overview of the micro-credential

This MC aims to provide students with useful tools to decarbonise any city from a broader perspective to a more focused outcome. We will consider a multilevel perspective to assess sustainable development. For that, we will use concept mapping and stakeholder analysis to evaluate the context of the city. In decarbonisation, it is essential using appropriate performance indicators and reporting to measure success. The MC will introduce students to city mapping software using ArcGIS. This software is helpful to visualise the evolution of indicators across the city. Once students get used to these tools, they will start to make decisions about the decarbonisation process. They will make multicriteria decisions based on AHP and ANP methodologies and optimise actions using multi-objective methodologies. Finally, all the tools converge into the development of decarbonisation roadmaps.

Learning objectives

On the completion of the micro-credential, participants will be able to:

- diagnose the urban energy systems to evaluate their sustainability
- employ tools like concept mapping, stakeholder analysis or city mapping to evaluate sustainable solutions
- select the best way of action through multicriteria decision-making and multi-objective optimisation.
- design a roadmap to decarbonise a city

Table of contents

- Sustainable development from a Multilevel perspective
- Concept and stakeholders mapping
- KPIs and reporting for sustainability
- City mapping software (GIS)
- Multicriteria decision making (AHP & ANP)
- Multi-objective methodology optimisation for sustainable projects
- Roadmap development for carbon-neutral cities

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, 8 hours, on the sustainability diagnosis tools and methodologies to select the best actions.
- Presentations, data sheets, case studies, work exercises, teaching aids, and research papers

Prerequisites

Basics on mathematics and physics at EQF 5
Principles on energy systems.

Assessment methods

Multiple choice questions.

MC-P37: Energy consumption in buildings

MC title	Energy consumption in buildings		
MC long title	Introduction to building energy consumption: concepts and assessment methods		
ISCED codes	*Primary*: 071	*Complementary*: 073	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6-7
Background of the proposed micro-credential			
The building sector accounts for more than 40% of the primary energy consumption worldwide and, consequently, it represents one of the major targets for energy efficiency measures and renewable energy system deployment. Understanding the ways energy is supplied and consumed at building level is a paramount step for assessing potential measures to reduce primary energy and carbon emission measures. This MC will introduce the learners to the main aspects related to energy consumption in buildings, from the main concepts and definitions to the assessment methods aimed at evaluating the building energy performance. We will also explore the most common technologies and strategies to reduce the heating and cooling energy demands at both building and district levels. Specific case studies will be developed and discussed, with a particular focus on energy efficiency measures and on the integration of RES technologies in buildings and districts.			
Overview of the micro-credential			
This micro-credential is aimed at providing a general understanding of energy consumption for building heating and cooling. The MC starts with the classification and impact of the building energy demand, description of the physical phenomena related to heating and cooling energy consumption, building energy systems, impact of weather conditions, performance indicators, etc. The learners will also be introduced to the fundamentals of building energy consumption modelling and assessment through the development of specific exercises and case studies, focussed on energy efficiency strategies and renewable energy technologies deployment, in which both technical and economic aspects will be considered.			
Learning objectives			
On the completion of the micro-credential, participants will be able to: • identify the main drivers of the building energy consumptions. • create simplified models for assessing and evaluating the heating and cooling demands. • detect solutions to improve the building energy performance			
Table of contents			
• Introduction to building energy consumptions: demand classification and impact, heating/cooling degree-days, building energy systems, performance indicators. • Building physic: heat transfer phenomena, heating and cooling energy demand evaluation, sub-systems efficiencies, energy efficiency measures, RES integration in buildings • Building energy modelling: calculation methods with exercises and case studies			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, work exercises, teaching aids, and research papers			
Prerequisites			
Basics on mathematics and physics at EQF 5.			
Assessment methods			
Multiple choice questions.			

MC-P38: Fundamentals of thermodynamics and heat transfer

MC title	Fundamentals of Thermodynamics and Heat Transfer		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
The acquisition of a general knowledge on the main physical principles of thermodynamics and heat transfer is fundamental to be able to analyse and evaluate renewable technologies and energy efficiency solutions. The learners will be introduced to the basic concepts and definitions to form a solid and sound foundation of the principles of thermodynamics and heat transfer, to support the comprehension of the physical mechanism occurring in energy technologies and systems. Although the topic of this MC is intrinsically technical, its general approach makes it suitable also for students with a limited STEM background.			
Overview of the micro-credential			
This micro-credential is aimed at providing a general competence on the main concepts of thermodynamics and heat transfer. This MC will provide a sound foundation on thermodynamics and heat transfer principles, through the identification of the specific vocabulary and precise definitions of the basic concepts – such as, units system, equilibrium, properties, process and cycle, etc. The energy transfer mechanism, such as heat transfer and work, and the concept of efficiency will be discussed in relation to the energy conservation principle, with the support of examples and exercises. Specific case studies related to renewable energy technologies and the building sector will be developed and discussed to transfer the theoretical knowledge acquired into practice.			
Learning objectives			
On the completion of the micro-credential, the learner: • has acquired the general language used in thermodynamics and heat transfer. • knows the main concepts of energy, process efficiency, properties of the matter, energy balance, unit measures and heat transfer mechanisms. • can identify and quantify the energy flows characterising a specific process and its efficiency			
Table of contents			
• Introduction to building energy consumptions: demand classification and impact, heating/cooling degree-days, building energy systems, performance indicators. • Building physic: heat transfer phenomena, heating and cooling energy demand evaluation, sub-systems efficiencies, energy efficiency measures, RES integration in buildings • Building energy modelling: calculation methods with exercises and case studies			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, work exercises, teaching aids, and research papers			
Prerequisites			
Basics of mathematics and physics at EQF 5.			
Assessment methods			
Multiple choice questions.			

MC-P39: Fundamentals of energy systems

MC title	Fundamentals of energy systems		
MC long title	Introduction to the energy system: concepts, characteristics and sustainability		
ISCED codes	*Primary*: 071	*Complementary*: 052	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7
Background of the proposed micro-credential			
Acquiring a general knowledge on energy resources and technologies is a paramount step towards the development of new skills and competences in the energy sector. This MC will introduce the learner to the main concepts related to energy, from its fundamental concepts to the main characteristics and features of the modern energy sector. We will explore the different energy resources and technologies, while their environmental impacts and sustainability will be discussed in light of recent developments and future perspectives. The MC is also suitable for learners with none or limited technical background, who want to start acquiring new skills in the energy sector.			
Overview of the micro-credential			
This micro-credential is aimed at providing a general understanding of the energy sector, by discussing its definition, boundaries, characteristics and environmental issues. The MC will introduce the learners to several technical concepts related to energy, such as: energy resource, primary and secondary energy, energy vector, energy conservation principle, process efficiency, energy consumption, environmental impact and resource renewability. Then, a general background on energy sources, with a special focus on renewable energies technologies, will be provided. Furthermore, the concept of sustainability, with reference to the UN Sustainable Development Goals (SDGs) and its meaning related to the energy sector, will be introduced.			
Learning objectives			
On the completion of the micro-credential, the learner: • has a clear understanding on the energy sector, its characteristics and features. • can navigate between the different energy source technologies. • understands the difference between non-renewable and renewable energy resources. • knows the concept of sustainability and environmental impact.			
Table of contents			
• Introduction to the concept of energy: definitions, units, conservation principle, efficiency concept. • Primary and secondary forms of energy, energy vectors, energy demand and consumption. • Energy sources and resources: definition, classification and environmental impact • Renewable vs non-renewable energy sources. • Sustainability aspects of the energy sector.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, work exercises, teaching aids, and research papers			
Prerequisites			
Basics of mathematics and physics at EQF 5.			
Assessment methods			
Multiple choice questions.			

MC-P40: Introduction to renewable energies

MC title	Introduction to renewable energies		
MC long title	Introduction to renewable energy systems: concepts and technologies		
ISCED codes	*Primary*: 071	*Complementary*: 052, 072	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7
Background of the proposed micro-credential			
Knowing the fundamentals of renewable energy sources (RES) is a paramount step towards understanding RES-based technologies and their potential applications. This MC will introduce the learners to the vast world of renewable energy systems, from the main concepts and definitions to the most recent technologies developed and their applications in different sectors. We will explore the different types of RES – from solar and wind energies to geothermal, hydroelectric and biomass technologies – from both theoretical and practical points of view. Specific case studies will be developed and discussed, with particular attention to the integration of RES technologies in urban areas.			
Overview of the micro-credential			
This micro-credential is aimed at providing a general understanding of renewable energy sources by discussing the different technologies and applications. The MC will start by introducing the learners to several basic definitions and concepts of the following RES: solar, wind, geothermal, hydroelectric and biomass. The technologies available, practical applications and design examples will be introduced and discussed for each RES. Special attention will be given to RES integration in urban context aimed at supporting the reduction of fossil-fuel consumptions and the sustainable transition of cities.			
Learning objectives			
On the completion of the micro-credential, the learner: • has a clear understanding of the definition and classification of renewable energy. • knows main features of solar, hydro, wind, geothermal and biomass sources. • can characterise the different RES technologies depending on the application			
Table of contents			
• Introduction to renewable energy sources: definition, classification, features and environmental impact. • Solar energy: characteristics of solar radiation, thermal solar technologies (thermal collectors, concentrated solar collectors), photovoltaic technology, applications. • Wind energy: characterisation of the wind source, wind turbines technology. • Geothermal energy: introduction, geothermal energy direct applications, power system generation, geothermal heat pumps. • Biomass: classification and properties, availability, biomass combustion, gasification, fermentation and anaerobic digestion. • Hydropower: characterisation of the hydro resource, classification, hydro turbines, small hydro.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, work exercises, teaching aids, and research papers			
Prerequisites			
Basics of mathematics and physics at EQF 5. Micro-credential P39			
Assessment methods			
Multiple choice questions.			

MC-P41: Urban metabolism strategies

MC title	Urban Metabolism strategies		
MC long title	Building a cleaner future throughout urban metabolism strategy		
ISCED codes	*Primary*: 073	*Complementary*: 052, 072	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7

Background of the proposed micro-credential

Urban metabolism and urban mine strategies are considered essential strategies to reduce environmental impact of human activities. This MC will lead the learners to the understanding of the complex meaning of waste and its many aspects, starting from the fundamental waste framework directive (2008/98/EC) and its new release. This is an essential starting point for understanding potential waste recovery strategies, particularly solid and construction and demolition waste at the urban level. We will explore the different approaches to valorise waste by reducing the consumption of raw materials, also by contributing to the reduction of the energy consumption (by considering that already embedded in pre-existing materials) required for their transformation. The MC is also suitable for learners with none or limited technical background, who want to start acquiring new skills in the energy sector

Overview of the micro-credential

The MC will introduce the concept of waste at the European level and the recently introduced changes in the definition of end-of-waste. The European classification of waste and the procedures for obtaining an end-of-waste classification are then presented. Methods for assessing the environmental impacts associated with the generation of construction and demolition waste are provided, followed by a description of the main material and waste streams at the urban scale. Also, a general framework on energy consumption and CO2 emission in production process of buildings materials will be provided. Recurrent urban metabolism and mining strategies are then provided. Students will then be introduced to the various methods of carrying out a pre-demolition audit of an existing building to maximise the value and reuse of existing materials.

Learning objectives

On the completion of the micro-credential, the learner:

- has a clear understanding of solid waste management, particularly construction and demolition waste;
- can choose between building materials and components with recycled content or virgin resources.
- Is able to map the urban settlement, considering buildings as urban mines and distinguishing between different residual materials to be valorised;
- knows the concept of sustainability and environmental impact in relation to the construction sector.

Table of contents

- Introduction to the urban metabolism concept.
- Waste in the construction sector and the process of waste generation at the urban level;
- End of waste valorisation strategies: metabolism and urban mining approaches.
- Environmental impacts of the construction sector: raw materials; energy and water consumption, embodied energy;
- Materials with recycled content and EPD (Environmental Product Declaration) certification
- Minimum environmental criterion in building sector at urban scale.

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lecturer, presentations, data sheets, case studies, work exercises, teaching aids, and research papers

Prerequisites

Basics of mathematics and physics at EQF 5.

Assessment methods

Multiple choice questions.

MC-P42: Digital payments and smart city platform

MC title	Digital payments and smart city platform		
MC long title	The role of digital payments in a smart city		
ISCED codes	*Primary*: 061	*Complementary*: 041	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6

Background of the proposed micro-credential

The European Union is committed in supporting the development of Smart Cities, where the use of digital solutions makes traditional networks and services more efficient for the benefit of its inhabitants and businesses. Among all aspects involved in the development of smart cities, the transformation of existing payment framework into smart payment plays a pivotal role in establishing innovative financing models and schemes. The inclusion of various digital payment models into the payment ecosystem across a variety of transactions between citizens, businesses and public institutions can act as facilitator for financial inclusions, transparency and new business opportunities across different sectors – such as, energy and water utilities, urban mobility, education, social services, healthcare, communities of citizens, taxes and fees, etc.

Overview of the micro-credential

This micro-credential is aimed at providing a general understanding on digital payment frameworks and their role in smart cities and communities. It will introduce the learner to the most innovative smart payment schemes and services in relation to smart cities and the arising new business and market opportunities. Methods to evaluate the digital payment readiness of a city will be introduced and discussed, together with the most important internal and external challenges faced by smart cities in developing and implementing smart payments. Finally, practical case studies and worldwide best practices will be discussed and analysed. The MC is also suitable for learners with none or limited financial or banking background, who want to acquire new skills and competence on payment schemes and financial services.

Learning objectives

On the completion of the micro-credential, the learner:

- understands the role of smart payment schemes in smart cities
- can identify and select the different payment methods and models.
- knows new market and business opportunities related to smart payments

Table of contents

- Introduction to Smart Cities and Smart Payments
- Strategic vision: the role of digital payments in smart cities
- Digital payments classification and framework
- Worldwide best practices: an overview of experiences from different countries

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lecturer, presentations, data sheets, case studies, work exercises, teaching aids, and research papers

Prerequisites

None

Assessment methods

Multiple choice questions.

MC-P43: Circular materials for a sustainable manufacturing

MC title	Circular materials for a sustainable manufacturing		
MC long title	-		
ISCED codes	*Primary*: 072	*Complementary*: 052	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7
Background of the proposed micro-credential			
Circular Materials (CMs) are defined as materials recovered from their first use and re-designed to be applied for a second application. Among the circular materials there are plastics, metal, natural fibres, etc. This MC is aimed at introducing the concept of CMs and the challenges of a circular design to achieve a sustainable production. The MC is suitable for learners with none or limited technical background, who want to start acquiring new skills in the materials science and technology.			
Overview of the micro-credential			
This micro-credential provides and overview about the motivations of CMs and what are the main challenges to convert a standard linear product design into a circular eco-design of sustainable goods. The MC will introduce the learners to the issues and limitations of recyclability with a general description of the chemo-physical properties that a CM should have. Then, a general background on the manufacture of CMs, with a special focus on the environmental impact, will be provided.			
Learning objectives			
On the completion of the micro-credential, the learner: • has a clear understanding on the definition and role of CMs; • is able to understand the challenges of CMs and circular design; • knows the most promising case studies of CRMs. • knows the main regulations and standards.			
Table of contents			
• Introduction to circular materials. • Definitions and role of circular materials • The challenges of circular materials and circular design. • Chemo-physical requirements of a circular materials • Case studies of circular materials and circular design applications.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, work exercises, teaching aids, and research papers			
Prerequisites			
Basics on mathematics, physics and general chemistry at EQF 5.			
Assessment methods			
Multiple choice questions.			

MC-P44: Introduction to life-cycle analysis of raw materials

MC title	Introduction to life-cycle analysis of raw materials		
MC long title	-		
ISCED codes	*Primary*: 072	*Complementary*: 052	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
A holistic approach over the whole supply chain in the energy sector is of fundamental importance to understand the multiple implication of the energy production and use. In this context, the learner will be introduced to the general methodology of life-cycle assessment (LCA), aimed at evaluating energy requirements and environmental impacts to produce and manufacture raw materials. This MC will present an overall schematic of the life-cycle assessment procedure, from its fundamental concepts to the main characteristics and limitations. The MC is suitable for learners with none or limited technical background, who want to start acquiring new skills in the sector of materials production and manufacturing.			
Overview of the micro-credential			
The micro-credential provides a general overview of the life-cycle assessment process, by discussing its general concepts, definition, boundaries, and limitations. The MC presents some basic definitions and technical concepts related to processes, such as: scope definition, inventory, impact assessment, interpretation and improved analysis. Methods to carry out an LCA analysis will be discussed from a theoretical and practical points of view. Then, some case studies will be provided as examples of applications.			
Learning objectives			
On the completion of the micro-credential, the learner: • has a general understanding on life-cycle assessment process, its advantages and limitations; • is able to define goal and scope of a LCA; • understands the concept of impact assessment; • knows the intrinsic LCA limitations.			
Table of contents			
• Introduction to the concept of LCA: motivation of the holistic approach “from cradle to grave”. • Setting the LCA goals and scope. • The LCA’s stages: inventory, impact assessment and analysis. • Role of Impact Categories in an LCA. • LCA applied to materials production and manufacturing.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, work exercises, teaching aids, and research papers			
Prerequisites			
Basics on mathematics, physics and general chemistry at EQF 5.			
Assessment methods			
Multiple choice questions.			

MC-P45: Understanding critical raw materials

MC title	Introduction to life-cycle analysis of raw materials		
MC long title	-		
ISCED codes	*Primary*: 072	*Complementary*: 052	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
Acquiring a general knowledge of the importance of Critical Raw Materials is of paramount importance in understanding what is the impact of material supply in the manufacture of high-tech products. This MC will introduce the importance of CRMs in Europe, the purpose of the CRMs list and what are the main challenges related to this topic. We will present the role of CRMs in the manufacturing processes and the strategies used by the EU to address the raw materials challenges. The MC is suitable for learners with none or limited technical background, who want to start acquiring new skills in the materials science and technology.			
Overview of the micro-credential			
This MC is an introductory guide to the Critical Raw Materials (CRMs) list created by the European Community. The list contains a group of raw materials, mostly minerals, that are strategic to the EU economy and are at risk of not being adequately supplied. The MC outlines the motivations of the EU's CRMs list and methodology used to set the list and it will introduce the learners to the main CRMs groups in the EU economy, with a general description of their chemo-physical properties. Then, a general background on the application of CRMs in industrial application, with a special focus on renewable energies technologies, will be provided. Finally some case studies about the importance of CRMs in the manufacture of high-tech products will be presented.			
Learning objectives			
On the completion of the micro-credential, the learner: • has a clear understanding on the definition and role of CRMs; • is able to browse EU documents about CRMs; • understands the challenge of CRMs in Europe; • knows the main applications of CRMs.			
Table of contents			
• Introduction to CRMs: definitions and role of CRMs in EU. • Purpose of the list of CRMs: main materials group and classifications. • Chemo-physical features of the main classes of CRMs. • Case studies of CRMs applications with a focus on energy-related applications.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, work exercises, teaching aids, and research papers			
Prerequisites			
Basics on mathematics, physics and general chemistry at EQF 5.			
Assessment methods			
Multiple choice questions.			

MC-P46: How sustainable is your city?

MC title	How sustainable is your city?		
MC long title	-		
ISCED codes	*Primary*: 052	*Complementary*: 031, 072, 073	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
Setting decarbonization targets is a crucial step taken by many cities to combat climate change and transition towards a sustainable future. These targets, often politically driven, signify a city's commitment to achieving carbon neutrality, usually by a specific year like 2040. However, the successful realization of these ambitions depends on the technical aspects of implementation and progress monitoring. The transformation towards a carbon-neutral city requires practical solutions backed by scientific analysis. City authorities need to employ a range of analysis tools to assess their current carbon emissions, identify major sources, and formulate effective strategies for reduction. These might include transitioning to renewable energy sources, improving public transportation, promoting energy-efficient buildings, and adopting circular economy practices.			
Overview of the micro-credential			
This MC aims to teach how cities can assess their decarbonisation target using sustainability indicators. The students will be taught the background for using indicators and be given an indicators framework with which they can compare how energy sustainable “their” city is compared to a perfect city. In particular, students will first learn the definition of sustainability, sustainable development goals and use of indicators. First, the students will be introduced to different indicators frameworks and, then a pre-selected framework will be provided to compare progress of sustainability of a case study city compared to a perfect city. They will learn tools and methods to understand how indicators become measurable.			
Learning objectives			
On the completion of the micro-credential, the learner: • Understand sustainable development goals • Understand how to assess cities • Understand how to apply an indicator framework on a specific city case.			
Table of contents			
• Introduction to sustainable development goals • Introduction on the development of indicators and their use. • Apply specific indicators framework on a specific city case and compare with a perfect city.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials			
Prerequisites			
Basics on mathematics of the concept of sustainable development			
Assessment methods			
Multiple choice questions. Assignments.			

MC-P47: Sustainable development goals for cities

MC title	Sustainable development goals for cities		
MC long title	-		
ISCED codes	*Primary*: 052	*Complementary*: 031, 072, 073	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
The United Nations' 17 Sustainable Development Goals (SDGs) serve as a comprehensive roadmap for global development, aiming to address various social, economic, and environmental challenges by 2030. Climate change and decarbonization play a crucial role in several of these goals, highlighting their integrative significance in achieving a sustainable future. The interconnection between the SDGs underscores the importance of a holistic and collaborative approach to sustainability, where addressing climate change and promoting decarbonization are integral components in achieving a prosperous and resilient future for all.			
Overview of the micro-credential			
This MC aims to teach sustainability and in particular decarbonisation using SDGs. First, students will learn the definition of sustainability, the background of the SDGs and different ways of assessing for performance towards SDG targets. Tools and methods to make indicators measurable will be introduced and discussed, and practical case studies will be provided. Students will then have the opportunity to apply the acquired knowledge and competence on a specific case study.			
Learning objectives			
On the completion of the micro-credential, the learner: • Understand the multidisciplinary nature of the sustainable development goals. • Understand how to assess SDGs with measurable indicators. • Understand how to apply SDGs on a specific city case.			
Table of contents			
• Introduction to sustainable development goals • Development of indicators to assess targets. • Case study definition. • Apply specific SDGs on a specific city case.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials			
Prerequisites			
Basics on mathematics of the concept of sustainable development			
Assessment methods			
Multiple choice questions. Assignments.			

MC-P48: Network Industries regulation and pricing

MC title	Network industries regulation and pricing		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 071	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
The energy networks are the backbone of the transition since they physically connect the end-users to the energy producers. Increasingly, these networks have a role to play in the shift to low-carbon energy, but also in maintaining a certain social equity in access to a "fair" price of energy. This is particularly the case at the local level, such as the city with the development and integration of decentralized generation. The activities of network operators, since they are not subject to competition, are regulated by a national regulatory authority and subject to the European legal framework that defines the limits of their activities and the economic incentives that drive their investments and operations. The recent upheaval in energy uses due to electrification and prosumption is challenging the foundations of current regulatory frameworks and calling for their modernization.			
Overview of the micro-credential			
This MC presents the theoretical foundations and empirical experiences of unbundling reforms for the vertical separation of network industries. It focuses on network industries at the local level (electricity distribution) and establishes their central role in the decarbonization effort. This MC presents the current change of paradigm faced by local grid operators in the energy transition context and stresses future challenges in grid development. It reviews the fundamental principles of regulated grid pricing, and the regulatory economic incentives for investment and operation on these networks.			
Learning objectives			
On the completion of the micro-credential, the learner: • Understand the drivers for unbundling • Understand the economic and organisational characteristics of network industries • Comprehend the upcoming challenges faced by local grid utilities • Review and analyse the impacts on grid tariff design on consumption and presumption • Analyse the impacts of key regulatory economic incentives on grid activities			
Table of contents			
• Presentation of energy sectors unbundling • European legal framework for grid activities • New paradigm and key challenges for local grid utilities • Rate making in electricity grids • Economic incentives for grid development			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials			
Prerequisites			
Basics knowledge on the development of distributed energy resources Basic knowledge on regulation and organisation of network industries			
Assessment methods			
Multiple choice questions. Assignments.			

MC-P49: Introduction to industrial organisation

MC title	Introduction to Industrial Organisation		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: -	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
The interactions between energy technology, industry structure, and government regulations are reshaping the energy industry and significantly affecting the emission reduction effort. Understanding the changes in energy industries needs the tools from industrial organization, which provides the theoretical foundations for producers and consumers' behavior under different market structures, e.g., wholesale electricity markets as high-frequency auctions, vehicle markets as price competition in oligopoly markets, and energy distribution firms as regulated natural monopolies. Therefore, it is important to illustrate how ideas and tools from industrial organization can be used to create insights into the understanding of energy industries and regulatory policies.			
Overview of the micro-credential			
This MC presents the theoretical foundations of industrial organization, together with applications in energy industry. It focuses on how markets work, how firms compete, and how government regulates. Importantly, this MC helps students to analyze and interpret firms' strategies and government's regulations from a strategic point of view, based on game theory. It covers the topics such as market structure, market power, market conduct, price discrimination, price competition, and government regulations.			
Learning objectives			
On the completion of the micro-credential, the learner: • Understand the concepts in measuring market structure and market power • Understand the fundamental concepts related to monopoly • Explain firms' behaviours and strategies in oligopoly markets • Analyse how government regulations could affect the market outcomes			
Table of contents			
• Game theory basics • Market structure and market power • Price discrimination and monopoly • Oligopoly markets and firm competition			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials			
Prerequisites			
Basics knowledge on microeconomics Basic knowledge on energy markets			
Assessment methods			
Multiple choice questions. Assignments.			

MC-P50: Building sustainable cities

MC title	Building sustainable cities		
MC long title	Building sustainable cities: the role of renewable energies		
ISCED codes	*Primary*: 071	*Complementary*: 031, 052, 073	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6-7

Background of the proposed micro-credential

As cities around the world continue to grow and become more populous, the need for sustainable and clean sources of energy is becoming increasingly important. One way that cities are addressing this need is by incorporating renewable energy technologies into their infrastructure. By using solar, wind, and other renewable energy sources, cities can reduce their carbon emissions and air pollution, making them more sustainable and liveable for their residents.

Overview of the micro-credential

This MC will first provide an overview of different renewable energy technologies commonly used in urban contexts; Next, introduce the students to the societal, environmental and financial implications of using renewable energy technologies. This could include discussions of the potential benefits and drawbacks, as well as challenges and opportunities associated with implementing these technologies; Encourage students to think critically about the role of renewable energy technologies in achieving sustainable and liveable cities, including the discussions on the importance of involving key stakeholders and decision makers in the implementation process, as well as the potential long-term benefits of using renewable energy technologies.

Learning objectives

On the completion of the micro-credential, the learner:

- Understand the technical aspects of different renewable energy technologies and their urban application.
- Analyse societal, environmental, and financial implications of renewable energy technologies in cities.
- Develop a critical understanding of the challenges and opportunities associated with implementing renewable energy technologies in cities.
- Explore strategies for effectively integrating renewable energy technologies into urban infrastructure.
- Understand the role of renewable energy technologies in achieving sustainable and liveable cities.

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- An overview of the different renewable energy technologies
- Analysis of the societal, environmental, and financial implications of using renewable energy technologies.
- Discussion on challenges and opportunities associated with implementing renewable energy technologies in cities, including issues related to policy, financing, and public acceptance.
- An exploration of strategies for effectively integrating renewable energy technologies.
- Case studies

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials

Prerequisites

Basics knowledge on energy production and consumption
Familiarity with renewable energy technologies
Basics on urban planning and development

Assessment methods

Multiple choice questions.

MC-P51: Urban renewable energy: decision-making methodologies

MC title	Urban renewable energy: decision-making methodologies		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 031, 071	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

As cities around the world continue to grow and become more populous, the need for sustainable and clean sources of energy is becoming increasingly important. One way that cities are addressing this need is by incorporating renewable energy technologies into their infrastructure. The adoption of renewable energy technologies in urban environments is not without challenges and requires effective decision-making processes to ensure that these technologies are integrated into urban infrastructure in a way that maximizes their benefits and minimizes their drawbacks.

Overview of the micro-credential

This MC aims to provide students with a comprehensive understanding of decision-making methodologies for the adoption of renewable energy technologies in urban contexts. The MC will cover a range of topics, including an overview of different decision-making technologies and methodologies, the identification of key decision variables and quantifiable factors, and an exploration of strategies for effectively integrating renewable energy technologies into urban infrastructure. Through a combination of lectures, discussions, case studies, and hands-on exercises, students will develop the skills and knowledge needed to make informed decisions about renewable energy technologies in urban environments. By the end of the MC, students will be able to analyse and evaluate the technical, social, environmental, and financial implications of using renewable energy technologies in cities, and to develop effective strategies for their implementation.

Learning objectives

On the completion of the micro-credential, the learner:

- Understand the principles and key concepts of decision-making methodologies for the adoption of renewable energy technologies in urban contexts.
- Identify the key decision variables and quantifiable factors involved in the adoption of renewable energy technologies in urban environments.
- Develop the skills and knowledge needed to analyse and evaluate the technical, social, environmental, and financial implications of using renewable energy technologies in cities.
- Understand strategies for effectively integrating renewable energy technologies into the infrastructure of urban areas, and for involving key stakeholders and decision makers in the process

Table of contents

- Analysis of different decision-making technologies and methodologies.
- Identification of key decision variables and quantifiable factors.
- Challenges and opportunities associated with implementing renewable energy technologies in cities.
- Exploration of strategies for integrating renewable energy technologies into urban infrastructure.
- Case studies of successful implementations of renewable energy technologies in urban environments

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials

Prerequisites

Basics knowledge on energy production and consumption
Familiarity with renewable energy technologies
Basics on urban planning and development

Assessment methods

Multiple choice questions.

MC-P52: Energy economics and policy

MC title	Energy economics and policy		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 031, 071	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
Effective energy policies are crucial in tackling global challenges, with a particular focus on urban areas due to their significant energy consumption and carbon emissions. While technological advancements play a vital role in decarbonization efforts, it is equally important to implement well-crafted policies that address the root causes of issues like climate change. Comprehensive energy policies should aim to promote renewable energy sources, enhance energy efficiency, and encourage sustainable practices in urban development and transportation. Moreover, these policies should consider social and economic aspects, ensuring inclusivity and affordability for all residents. By understanding the interconnectedness between technology, policy, and climate change mitigation, cities can become powerful agents in the global transition towards a low-carbon and sustainable future.			
Overview of the micro-credential			
This MC aims to teach energy policy and finance from a global to a regional perspective, such cities. It is vital to understand the energy policy that addresses the global challenges by focusing on policies implemented in urban areas. Learners will first learn the definition of energy policy and its importance for mitigating climate change. Technological improvements will be outlined in the framework of energy policy contexts. Furthermore, tools and methods to understand the need for a policy and how to develop a policy will be introduced. The energy market data will be exploited during the demonstration of the methods.			
Learning objectives			
On the completion of the micro-credential, the learner: • Understand the Energy and Energy Resources • Understand the Energy and Sustainable Growth • Understand the European Energy Policy			
Table of contents			
• Overview of Economics and Statistics • Introduction to Energy and Energy Resources • The Economics of Energy • European Energy Policy • Time Series Analysis in Energy Economics			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials			
Prerequisites			
Basics understanding on sustainable development and climate change. Basic knowledge of energy policy.			
Assessment methods			
Multiple choice questions.			

MC-P53: Energy justice and poverty

MC title	Energy justice and poverty		
MC long title	-		
ISCED codes	*Primary*: 031	*Complementary*: 041, 071	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6

Background of the proposed micro-credential

Economy, environment, society and technologies represent the main pillars of a sustainable development. While assessments and tools for measuring the impact on the technology, economy and environment dimensions are relatively well established, the social dimension remains in a developmental stage, lacking quantifiable variables and robust assessment tools. Therefore, there is a critical need to explore and strengthen the social dimension of sustainability, with a particular focus on areas like energy justice and poverty. Addressing energy justice is essential as it ensures that vulnerable and marginalized populations are not disproportionately burdened by the transition to sustainable energy sources. Furthermore, poverty alleviation is intricately linked to sustainability, as socio-economic well-being is a fundamental aspect of human development. Sustainable policies should address poverty and income inequality, creating opportunities for upward mobility and enhancing the overall quality of life.

Overview of the micro-credential

This MC aims to assess the social dimension of sustainability by specifically focusing on the poverty and justice issues of policy and technology implementations. Learners will first leaner the definition of energy poverty in different countries. There are many definitions, and there is no consensus on one single definition. The measures of energy poverty will be an additional topic to be covered. Linked to energy poverty, the MC will cover procedural, distributional, and recognition justice. The importance of these two main concepts on policy development and technology uptake will also be covered.

Learning objectives

On the completion of the micro-credential, the learner:

- Understand the concept of the energy poverty
- Understand the energy poverty measurements
- Understand the energy justice concept
    - Procedural Justice
    - Distributional Justice
    - Recognition Justice
- Understand the policy development by using energy poverty and justice concepts.

Table of contents

- Definition of energy poverty
- How energy poverty is measured
- The different implementations of the energy poverty policies in Europe
- Definition and pillars of Energy Justice
- Energy policy and social issues

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials

Prerequisites

Basics understanding on sustainable development and climate change.
Basic knowledge of energy policy.

Assessment methods

Multiple choice questions.

MC-P54: Regulatory framework conditions for Power-to-X

MC title	Regulatory framework conditions for Power-to-X		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 041	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 8
Background of the proposed micro-credential			
Future decarbonised energy mix will rely on large share of variable renewable energy and will require greater cross-sector coupling both between energy sectors (electricity, transportation, heat, hydrogen), but also with other economic sectors with great potential for flexibility and energy production as a by-product of their activity (waste heat). This greater electrification and coupling will bring flexibility gains to the electricity sector and accelerate decarbonization across the targeted sector. However, this integration is currently limited by siloed regulatory frameworks that overlook the synergy effects of P2X, calling for a better understanding of regulatory bridges across sectors to fast forward sector coupling.			
Overview of the micro-credential			
This MC presents the technical potential and regulatory challenges related to sector coupling in the context of sustainable transition. It provides the conceptual and methodological tools to identify, map, test and analyse the scope of regulatory frameworks at the interface of energy sectors for P2X development**,** encompassing electricity, heat, transportation and other key economic sectors. Participants will be confronted with the decision maker's toolbox and will be asked to rethink some of these tools to foster the fastest growth of sector coupling.			
Learning objectives			
On the completion of the micro-credential, the learner: • Understand the drivers for sector coupling • Comprehend how key regulatory framework conditions may hinder or accelerate sector coupling • Test and analyse the business case for key P2X strategies under different regulations • Compare the effects of regulation on investment and operation choices of energy equipment			
Table of contents			
• Overview of sector coupling: A system perspective • Case studies of P2X strategies • Regulatory framework conditions for P2X • Impact of regulation on P2X development			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials			
Prerequisites			
Basic knowledge of energy systems and transition Basic knowledge in economics and policy			
Assessment methods			
Multiple choice questions. Assignments			

MC-P55: Social acceptance of technologies

MC title	Social acceptance of technologies		
MC long title	-		
ISCED codes	*Primary*: 031	*Complementary*: 041	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
The social dimension of sustainability is a vital aspect that requires deeper exploration, with one crucial element being the social implications of implementing sustainable technologies. Understanding the barriers and concerns faced by consumers, investors, and policymakers is crucial for successful and inclusive technological diffusion. Engaging with the public allows for a comprehensive understanding of societal needs and values, ensuring that technological solutions align with the preferences and aspirations of the communities they will impact. It helps identify potential challenges and ensures that the technology is accessible and beneficial to all segments of society, including marginalized and vulnerable populations. Therefore, incorporating public engagement as a fundamental step in sustainable technological implementation is imperative for addressing social concerns and ensuring that technological advancements align with the broader vision of a sustainable and equitable future.			
Overview of the micro-credential			
This module aims to assess the social dimension of sustainability by specifically focusing on the social acceptance of technology by society. Learners will first learn the definition of social acceptance and its importance for technology implementation and policy development. Then, the three-pillar approach to social acceptance will be covered: socioeconomic acceptance, market acceptance and community acceptance. A framework for quantifying social acceptance will also be presented. Quantified social acceptance will help decision-makers in a data-driven decision process.			
Learning objectives			
On the completion of the micro-credential, the learner: • Understand the concept of social acceptance • Understand the methods of public engagement for technology • Understand the importance of social acceptance in decision making			
Table of contents			
• Definition of social acceptance • How social acceptance is measured • How barriers to technology implementation are determined • The framework for social acceptance determination • Energy policy and social acceptance			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, teaching aids, and reading materials			
Prerequisites			
Basic knowledge on sustainable transition and energy policies			
Assessment methods			
Multiple choice questions. Assignments			

MC-P56: Hydrogen technology for urban areas

MC title	Hydrogen technologies for urban areas		
MC long title	-		
ISCED codes	*Primary*: 072	*Complementary*: 041, 071	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
The momentum behind hydrogen is currently unprecedented, with governments and companies worldwide initiating numerous policies, projects, and plans. Hydrogen is being presented as a promising solution to expedite the transition away from fossil fuels for heating and cooling in urban areas. This versatile element has the potential (i) to foster the integration of more renewables, bolstering storage and maximising renewable energy potential, (ii) to be combined with carbon capture and storage (CCS), (iii) to decarbonise hard-to-abate sectors and (iv) to enhance energy security by diversifying the energy mix. However, challenges persist. Costs must decrease, infrastructure development is crucial, and cleaner hydrogen production methods are needed. Additionally, regulatory barriers hinder progress, and experts debate the uncertainties and risks of potential lock-in effects.		
Overview of the micro-credential			
This MC tries to raise the following questions: Are we in a golden age of hydrogen? Is hydrogen efficient? Is hydrogen cost-competitive? What infrastructure for the use of hydrogen in the cities? Is the use of hydrogen rather easy or disruptive for citizens? When will the hydrogen and fuel cell technologies be ready to provide clean transportation and heat cities? Learners will navigate among the different hydrogen technologies and application to understand their main features, challenges and opportunities.		
Learning objectives			
On the completion of the micro-credential, the learner will: • acquire knowledge and competences to evaluate current and future challenges concerning development, deployment and implementation of CO2 free H2 value chain. • be able to identify opportunities to solve problems of H2 supply chain needed to reach climate goals. • understand the H2 trading and delivery systems.		
Table of contents			
• Introduction to hydrogen technologies and value chains: • Hydrogen production, transportation and storage. • Hydrogen application per sector. • New strategies for the development of new H2 technologies. • Clean H2 economy, safety and regulations.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets, case studies, and reading materials			
Prerequisites			
None			
Assessment methods			
Multiple choice questions. Quantitative exercises.			

MC-P57: Cost and energy modelling

MC title	Cost and energy modelling		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 061, 071	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7

Background of the proposed micro-credential

The complexity of energy systems requires the accounting of all drivers and interactions between technical and economic variables. The purposes of energy modelling are:

- draw coherent images of the future in a set of assumptions about population, economic growth, the level of resources and the policies implemented, performance of technologies and types of behaviour of actors.
- Identify potential tensions, on energy security, stability of global energy markets and reductions in greenhouse gas emissions, providing important information about system feasibility, greenhouse gas emissions, and total costs.

Assess the cost of long-term policies, especially climate policies, anticipate the risks, appreciate adaptive capabilities through technology.

Overview of the micro-credential

The MC "Cost and energy modelling" intends to provide knowledge on modelling principles, types and their role in responding to current important questions. Explanation of modelling methodologies, construction of databases; functions for estimating energy consumption by sector and energy (particularly building heating and cooling); modelling energy carriers: electricity and hydrogen; methodology of modelling: international prices, primary energy extraction and production; marginal abatement costs, construction of scenarios; consider the increasing role of climate policies and their impact on energy demand and supply planning, types of software for optimisation or recursive dynamic simulation.

Learning objectives

On the completion of the micro-credential, the learner will be able to:

- Explain how to choose the best energy mix based on specific demands.
- Consider the design and evaluation of transformative processes in interlinked social, technological and economic systems.
- Develop a new capability to capture spatial and social heterogeneity.
- Deepen the integrated assessment of mitigation pathways in terms of a multi-dimensional assessment of costs, benefits due to avoided impacts and to interaction with other sustainable development goals.

Table of contents

- Functions of energy forecasting
- Types of models and their role. The main features of the POLES model
- Database and exogenous assumptions
- Carriers: electricity and hydrogen
- Methodology of modelling: international prices, primary energy extraction and production
- Marginal reduction costs
- Construction of scenarios and dynamic simulations

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lecturer, presentations, data sheets, case studies, and reading materials

Prerequisites

Basic understanding of energy systems

Assessment methods

Multiple choice questions and quantitative exercises.

MC-P58: Decision-making for energy projects under uncertainty

MC title	Decision making for energy projects under uncertainty		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 061	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7-8
Background of the proposed micro-credential			
Dynamic optimization and real options theory are essential concepts in economics and finance. Dynamic optimization involves making decisions over time, considering the dynamic nature of economic systems. It helps address complex problems with significant future implications. Real options theory extends financial options to real-world investment decisions, allowing for flexibility and risk management in uncertain environments. The energy sector is intrinsically dynamic, since it is influenced by policy, regulations, and technological advancements, making dynamic optimization and real options invaluable in decision-making. They inform resource allocation, investment strategies, and risk mitigation, contributing to sustainable and adaptive solutions.			
Overview of the micro-credential			
This MC aims to introduce participants to theoretical aspects of dynamic optimization and considers implications of real options theory to decision-making process. Applications will focus on problems in energy and environmental economics. Policy and regulation uncertainty and their impact on the investment decision and behavior of investors will also be examined. Learners will be trained on classical investment analysis approach (e.g., NPV) and will learn how to model a decision-making process related to energy investments under uncertainty. Tools and methods to identify the optimal time to invest and the option value will be provided, together with practical examples solved in common software (e.g., Excel and Matlab).			
Learning objectives			
On the completion of the micro-credential, the learner will: • acquire skills on modelling in energy economics. • be able to model a decision-making process related to energy investments under uncertainty • be able to compare different investment strategies in uncertain context to choose the optimal one • apply conceptual and analytical economic models to real life problems			
Table of contents			
• Introduction on economist's toolbox for investment decisions • Limits of traditional approaches under uncertainty • Fundamentals on market uncertainty and assessment methods • Usefulness and limits of a real options approach • Optimal investment timing and option value • Strategic options in real investments: examples from energy and environmental field			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data sheets and data colelction, case studies, and reading materials			
Prerequisites			
Interest in energy economics, energy technology. Basics of mathematics and numerical models			
Assessment methods			
Multiple choice questions. Exercises and tests.			

MC-P59: Strategic behaviour in energy markets – options and games.

MC title	Strategic behaviour in energy markets: option and games		
MC long title	-		
ISCED codes	*Primary*: 061	*Complementary*: 041	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

Since the 1990s, feed-in tariffs have been one of the most widely applied energy policies to stimulate renewable energy. Nevertheless, feed-in tariff schemes have been victims of their own success and have been criticized for leading to unreasonable and uncontrollable costs. Auctions have been proposed as an alternative to feed-in tariffs and are becoming an increasingly popular energy policy to promote renewable energy. The aim of auctions is to create more competition to reduce production costs. Thus, by fixing in advance the volume of energy that will be put up for auction, the public budget made available can be controlled in advance, which is not the case with an open window in the case of a feed-in tariff. In this context, various economics tools allow to assess the effect on investor's decision of an increased competition under market uncertainties.

Overview of the micro-credential

This MC lies at the crossroads of economics and operational research, with primary objectives focused on various aspects of market design for auctions across different European countries and technologies, such as green hydrogen and biogas. The course aims to establish a benchmark for these designs, outlining key elements and associated economic modeling frameworks. Participants will gain insights into the results and limitations of different auction frameworks, particularly in the context of renewable electricity. Additionally, the MC will delve into the utilization of option games modeling to explore strategies and uncertain payoff functions within diverse market models, including duopolies, oligopolies, and two-sided platforms. By examining these topics, attendees will develop a comprehensive understanding of auction mechanisms and their implications, enabling them to make informed decisions and devise strategies in complex and dynamic economic environments.

Learning objectives

On the completion of the micro-credential, the learner will:

- acquire skills in using energy economics toolbox and decision-making criteria.
- be able to valuate energy projects under competition, strategic behavior, and price uncertainty.
- develop critical thinking of complex market strategies with an option-games approach.

Table of contents

- Introduction on general auction theory of market design
- Market models for strategic interactions between economic agents.
- Game theory description and real options approach
- Real case study examples on a small energy project

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lecturer, presentations, data collection and analysis, numerical case studies and reading materials

Prerequisites

Interest in energy economics, energy technology.
Basics of mathematics and numerical models

Assessment methods

Multiple choice questions.
Exercises and tests.

MC-P60: Energy policy and flexible technologies

MC title	Energy policy and flexible technologies		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 061	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 7-8
Background of the proposed micro-credential			
The increasing adoption of flexible technologies, such as electric vehicles, energy storage systems, and decentralized renewable energy sources, presents unique challenges and opportunities for the distribution network infrastructure. To effectively deploy these technologies, new investments or the modernization of existing networks become essential. Furthermore, understanding the economic implications of flexible technology integration is vital for policymakers, investors, and industry players seeking to build a sustainable, adaptive, and efficient energy landscape for the future.			
Overview of the micro-credential			
This MC aims to address the economy of flexible technology integration. Flexible technology like electric vehicle, storage and decentralized renewable energy need a specific distribution network to be deployed by new investments or modernizing existing networks. The MC drives students in understanding how to assess the theoretical business model for coordinating investments in network and flexible technologies. It includes elements related to: (i) distribution network investments, (ii) economy of flexible technologies, (iii) business models of flexible technologies, (iv) investment coordination strategies.			
Learning objectives			
On the completion of the micro-credential, the learner will: • acquire knowledge on flexible technologies. • understand business models for flexible technologies. • be able to identify strategies to coordinate investments in network and flexible technologies.			
Table of contents			
• Introduction on long-term distribution network investments. • Definition of flexible technologies. • Economic dimension of flexible technology. • Strategies to support the coordination of investments.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data collection and analysis, numerical case studies and reading materials			
Prerequisites			
Interest in energy economics and energy technology. Basics on business models in the electricity sector.			
Assessment methods			
Multiple choice questions. Exercises and tests.			

MC-P61: Renewable energy investments

MC title	Renewable energy investments		
MC long title	Renewable energy investments and electricity markets.		
ISCED codes	*Primary*: 041	*Complementary*: 071	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6-7
Background of the proposed micro-credential			
Renewable energy investment has emerged as a critical driver in the global transition towards a sustainable and low-carbon future. Renewable energy investment involves financing projects that harness natural resources such as solar, wind, hydro, geothermal, and biomass to generate clean electricity. These investments play a pivotal role in accelerating the deployment and advancement of renewable technologies, fostering energy security, and creating economic opportunities. The attractiveness of renewable energy investment lies not only in its environmental benefits but also in the declining costs and technological advancements, making it increasingly competitive with traditional fossil fuel-based energy sources.		
Overview of the micro-credential			
This MC aims to give an overview on the main challenges and barriers to investments in renewable generation. It describes the theory and the practices regarding EU electricity markets design and how they deal with renewable market integration in line with network access and use practices specific to renewable. It covers topics such as: electricity market design, renewable energy tariffs and prices, renewable network access and utilization, challenges and opportunities for renewable energy investments.		
Learning objectives			
On the completion of the micro-credential, the learner will: • acquire knowledge on renewable energy market. • understand incentive tools and strategies for renewable investments. • be able to navigate the different energy investment strategies.			
Table of contents			
• Introduction on electricity market design and operation. • Renewable long-term investment strategies. • Coordination policies for renewable investments. • EU best practices			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data collection and analysis, numerical case studies and reading materials			
Prerequisites			
Interest in energy economics and renewable energy technology. Basics on electricity markets			
Assessment methods			
Multiple choice questions. Exercises and tests.			

MC-P62: Electricity network regulation

MC title	Electricity network regulation		
MC long title	Electricity Network Regulation: EU regulatory incentives for energy transition		
ISCED codes	*Primary*: 041	*Complementary*: 071	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 7
Background of the proposed micro-credential			
Electricity network regulation plays a vital role in ensuring an efficient, reliable, and sustainable energy supply. Price cap regulation and various incentive regulation schemes aim to strike a balance between providing fair prices to consumers while incentivizing investments and improvements in the electricity network. Additionally, the evaluation and comparison of these regulatory methods become even more critical in the context of integrating renewable energy sources into the grid. As renewable energy plays an increasingly significant role in the energy transition, understanding the implications of different regulatory models becomes essential for fostering a resilient and environmentally friendly electricity network.			
Overview of the micro-credential			
This MC offers a comprehensive overview of electricity network regulation, focusing on key regulatory approaches like price cap regulation, cost plus regulation, menu of contract, and yardstick competition. Participants will explore the principles and implications of each model, with real-world case studies and applications. Understanding the intricacies of these regulatory methods is crucial in fostering competition, efficiency, and fair prices in electricity markets. Moreover, the course will examine the relevance of these models in integrating renewable energy sources into the grid. By the end of the course, participants will gain valuable insights into creating an efficient, sustainable, and resilient electricity network through effective regulatory strategies.			
Learning objectives			
On the completion of the micro-credential, the learner will: • acquire knowledge on regulation theory in energy economics. • understand the variety of regulation tools. • learn the economic basis of network tariffs.			
Table of contents			
• Introduction on electricity market regulation. • Theory of incentive regulation • Network regulation in Europe • Specific regulation of R&D investments • UK innovative regulatory scheme.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lecturer, presentations, data collection and analysis, numerical exercises and reading materials			
Prerequisites			
Interest in energy economics and renewable energy technology. Basics on electricity markets			
Assessment methods			
Multiple choice questions. Exercises and tests.			

MC-P63: Positive energy buildings

MC title	Positive energy buildings		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 061, 073	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

Positive Energy Buildings are buildings that, on yearly average, produce more energy than they consume. Producing more energy on average does not mean that they do not need connections to grids (electric and heat and other fuels). So Positive Energy Buildings basically face the same hurdles than Positive Energy Territories but with a reduced scale. How much energy can be produced locally? How much of this energy can be produced in a synchronised time with the consumers' needs?

Overview of the micro-credential

This MC offers a comprehensive overview of Positive Energy Buildings, which are designed to produce more energy on a yearly average than they consume. Participants will delve into the concepts of local energy production and synchronization with consumers' needs. Key questions will be addressed, such as determining the potential for local energy production and ensuring it aligns with demand patterns. Through case studies and practical examples, participants will gain insights into the design, technologies, and strategies employed to achieve the positive energy balance in buildings.

Learning objectives

On the completion of the micro-credential, the learner will:

- understand the different "patterns" of PV production and building consumption: daily/seasonal variations
- have basics capacities to work with the building characteristics: peak power, average power, energies, efficiency of storage, variability, flexibility potential.
- understand the basics of the limits of the "self-consumption" ratio.
- be able to design a combination of PV and battery systems as a function of targeted "self-consumption" ratio.

Table of contents

- Introduction on the variabilities of PV production and building consumptions.
- Introduction on the metrics of "self-consumption" and actual impacts.
- Exercise with a dedicated notebook to design a combined PV+home battery.
- More complex exercises with the introduction of the probabilistic dimension.

Teaching and learning methods

The following teaching and learning methods will be used:

- Online videos with self-tests will be used to drive the students in the definitions
- Reading materials, online software and tools.

Prerequisites

Fundamentals of energy physics.
Very basics computer programming (e.g., python)

Assessment methods

Multiple choice questions.
Exercises and tests.

MC-P64: Physics of energy

MC title	Physics of energy		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: -	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
Energy is a very common notion for physicists. Nevertheless, and despite a good access to objective numbers, it raises intense debates in the public and in the news. How to discuss the potential of a technical solution to a specific individual or collective energy need? How to rank the priorities between decarbonisation solutions when rough numbers of individual needs are not known and/or not easy to compare to another? How to change the units of energies?			
Overview of the micro-credential			
This MC aims at filling the toolbox of the energy specialist or manager, by give the student essential definitions, numbers, order of magnitudes that allow to seize the needs for energy and the potential of the different technologies of renewable sources and fuels available in urban areas. By filling the gap between the definitions of the physicist and the daily use of words, by understanding the paradoxes of first laws of thermodynamics, by handling classical numbers of energy sources, vectors or usage at different sizes or times, this MC will provide students with a comprehensive background to understand the energy concept and its real-life application.			
Learning objectives			
On the completion of the micro-credential, the learner will: • be able to understand the concept of energy and its meaning in the every-day life. • acquire knowledge and practical ability to use definitions of energy units, orders of magnitude of needs and usages. • be able to classify, rank, know, discuss the potentials, the limits in terms of simple metrics of physicists of different solutions foreseen to increase the use of renewable energies in cities			
Table of contents			
• Introduction on energy usages, sources and energy systems. • Discussion on the laws of thermodynamics, metrics, units and orders of magnitudes. • Review of existing energy sources and vectors.			
Teaching and learning methods			
The following teaching and learning methods will be used: • Online videos with self-tests will be used to drive the students in the definitions. • Reading materials and tools.			
Prerequisites			
Basic knowledge of mathematics and physic at EQF 5.			
Assessment methods			
Multiple choice questions.			

MC-P65: Economics and physics of energy storage

MC title	Economic and physics of energy storage		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 041, 072	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 7-8

Background of the proposed micro-credential

Electricity mixes with high shares of Variable Renewable Energies (VRE) require the combination of flexibility options. Urban areas being dense and diverse in energy consumers are expected to contribute to these flexibilities, with the opportunity to warm and store domestic hot water and more generally store heat (maybe in heat networks) and load electric cars at the most critical times to help the grid operators and maximise the use of available renewable energies. The frequency of use of storages and then its economic model depends on technical design options such as peak power, energy stored and efficiencies but also on the actual variability of demand combined with the one of supply that can be rich in VRE and/or rich in flexible generations.

Overview of the micro-credential

The aim of this MC is to link the different time and space scales and to link technical and economic aspects of the design of storages. Storages of electricity or heat are usually seen as a bridge between the time of consumption and the one of production, in energy mixes with high shares of Variable Renewable Energies (VRE). With the development of Heat-pumps and electric cars, storages are also bridges between energy uses. In fact, they are also a bridge between different space-scales as dense urban areas are well connect to regional and continental grids. Those grids are not only used as backups, but they also allow for excessive local production to be used elsewhere and reciprocally the local uses or storages may be able to contribute to the need of flexibility of the larger scales. The participants will use on-line notebooks of growing complexities to model small energy systems, link the technical and economic aspects of energy storages, link energy usages, and connect time and space scales.

Learning objectives

On the completion of the micro-credential, the learner will be able to:

- Design local energy storage systems as a function of available Variable Renewable Energies
- Adjust the design of local storages as a function of flexibility needs of different space scales, eg. building and national grids.
- Link technical aspects with economic model of storages.

Table of contents

Simple local energy models of growing complexities will be used:

- One simple local model with 2 or 3 sources to discuss the need for storage at different timescales.
- Addition of flexible electricity uses: heat storage and smart charging of Electric Vehicle (G2V) and optional Vehicle to Grid (V2G).
- One model with 2 simple, energy systems to connect local storages with regional grids and markets to introduce the economic questions.

Teaching and learning methods

The following teaching and learning methods will be used:

- Online videos with self-tests will be used to drive the students in the definitions.
- Reading materials, numerical models and tools.

Prerequisites

Basic knowledge of mathematics and physic at EQF 6.
Basic programming skills are required.

Assessment methods

Multiple choice questions.

MC-P66: Biogas systems for climate transition

MC title	Biogas systems for climate transition		
MC long title	Biogas production and use for sustainable cities		
ISCED codes	*Primary*: 072	*Complementary*: 052, 071	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6

Background of the proposed micro-credential

Biogas systems offer cities numerous benefits, transforming urban landscapes sustainably. By utilizing household waste, sewage sludge, and industrial organic waste, cities can manage organic waste effectively, reducing landfill usage and pollution. These systems promote circular economies, enhancing energy self-sufficiency and resilience. Biogas contributes to combating climate change by curbing greenhouse gas emissions and serves as a renewable transportation fuel, reducing air pollution. Furthermore, the implementation of biogas infrastructure generates employment opportunities, bolstering the local economy. By embracing biogas technology, cities can lead the way in green innovation and environmental stewardship, ensuring a brighter and more sustainable future.

Overview of the micro-credential

This MC provides a thorough introduction to the fascinating microbiological processes that facilitate oxygen-free digestion and its role in biogas production. Exploring the impact of various substrates and parameters on biogas generation, students gain a profound understanding of optimizing the process. The course delves into different digestion systems and processes, allowing students to comprehend their unique applications and advantages. As the course progresses, students are exposed to diverse application options for biogas and digestion residues, uncovering the versatility of this renewable resource. A pivotal aspect of the curriculum lies in the in-depth analysis of the environmental and economic benefits associated with biogas systems. By the end of this course, learners are equipped with the knowledge and skills to contribute meaningfully to the sustainable energy landscape, addressing environmental concerns while recognizing the economic viability of biogas systems.

Learning objectives

On the completion of the micro-credential, the learner will be able to:

- describe different types of oxygen-free digestion systems and those most common constituent components in these, as well as being able to describe the most likely applications for these technologies.
- understand the most important environmental issues related to the digestion process, biogas and residue, as well as being able to clarify the meaning of these in relation to environmental protection issues.
- explain the different areas of use for biogas. From given conditions be able to justify which areas of use bring the greatest profit with a perspective on sustainable development.
- evaluate how biogas technology can contribute to a long-term Sustainable Development

Table of contents

- Simple local energy models of growing complexities will be used:
- Microbiology of anaerobic digestion and substrates for biogas production
- Classification of digestion systems
- Use of biogas in society, environmental benefits and biogas for climate transition
- Sustainability of the biogas system

Teaching and learning methods

The course is delivered as a distance course where the student works independently and computer-based; reads texts, writes essays, answers multiple choice questions and perform simpler calculations. The student will also have access to video lectures and other teaching materials.

Prerequisites

None

Assessment methods

Multiple choice questions.

MC-P67: Circular economy for sustainable cities

MC title	Circular economy for sustainable cities		
MC long title	Circular economy: from household waste to material recycling		
ISCED codes	*Primary*: 052	*Complementary*: 072	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6

Background of the proposed micro-credential

The circular economy is an imperative for fostering sustainability in societies and companies. Sustainable cities benefit immensely from circular systems, spanning household waste management, material recycling, waste-water treatment, and renewable energy. Embracing circularity enhances resource efficiency, reduces waste, and promotes environmental well-being. Efficient household waste handling, through recycling and composting, minimizes landfill impact while channelling resources back into the economy. Circular waste-water treatment allows for valuable nutrient and energy recovery, ensuring water conservation. Circular energy systems, utilizing renewables like solar and wind power, reduce reliance on finite resources and combat climate change. By implementing circular practices, cities can create greener, more resilient urban environments, forging a path towards a sustainable and prosperous future.

Overview of the micro-credential

This MC offers students a comprehensive understanding of the significance of transitioning towards a circular economy to address pressing sustainability challenges. Exploring the principles of environmental economics and various policy instruments, learners gain insights into the critical issues surrounding sustainability. Emphasizing the interconnectivity of circular approaches in both private and public spheres, the course illuminates the far-reaching impact of circularity on diverse sectors. By delving into the design and effectiveness of policies and instruments supporting this transition, students grasp how circularity can drive sustainable practices. Through this course, participants will be equipped with knowledge and tools to contribute to shaping a more sustainable and resilient future, both at individual and systemic levels.

Learning objectives

On the completion of the micro-credential, the learner will be able to:

- identify and describe basic linear and circular economic concepts at the micro, meso and macro level as well as account for which control instruments are used for a sustainable economy.
- develop a deeper understanding of dynamics and complexity in the interaction between circularity and economic development.
- critically review academic research and argue for different forms of explanations about industrial change and company actions with particular focus on resource efficiency.
- analyze and discuss relevant policies and instruments for the circular economy.

Table of contents

- Circular versus linear economy, waste handling
- Recycling of materials and water
- Tools for circular economy assessments
- Environmental benefits with circular economy and sustainability
- Business models to support circularity.

Teaching and learning methods

The course is delivered as a distance course where the student works independently and computer-based; reads texts, writes essays, answers multiple choice questions and perform simpler calculations. The student will also have access to video lectures and other teaching materials.

Prerequisites

None

Assessment methods

Multiple choice questions.

MC-P68: Management of innovation projects

MC title	Management of innovation projects		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 031, 072	**ECTS:** 2.5
Suitable for	☒ STEM ☒ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
The transition towards sustainable energy solutions has amplified the significance of project management skills tailored to renewable energy systems. As societies worldwide strive to reduce their carbon footprint and embrace cleaner alternatives, renewable energy projects have become instrumental in achieving these environmental objectives. From solar and wind power installations to bioenergy and geothermal initiatives, these projects encompass a diverse range of technologies. Effectively managing innovation projects in the renewable energy sector requires a unique blend of technical expertise and proficient project management methodologies. Precise planning, optimal resource allocation, risk assessment, and collaboration with stakeholders are vital for successful project execution. Additionally, staying up to date with the latest renewable energy technologies and industry advancements is crucial for making informed decisions and driving project success.			
Overview of the micro-credential			
This MC delves into innovation from a project management standpoint, with a specific focus on three critical areas: new product development projects, projects for internal process change, and multiproject environments. These domains share a common characteristic: high uncertainty and a multitude of influencing factors, involving interdependent stakeholders. Through this course, students will gain valuable insights into handling the complexities and challenges associated with innovative projects. They will learn effective planning techniques, risk management strategies, and stakeholder engagement approaches tailored to each area. The curriculum will equip learners with the necessary skills to navigate the intricate web of dependencies and uncertainties, ensuring successful outcomes in diverse innovation contexts.			
Learning objectives			
On the completion of the micro-credential, the learner will: • possess an in-depth understanding of change projects in internal processes. • know the management procedures for multi-project environments. • be able to handle new product development projects, how to lead them during their typical life cycle.			
Table of contents			
• Project management principles: organization, planning, tools and technologies, implementation process, stakeholders and communication and risk management of innovation projects. • New product development project: history, agile and iterative methods and lifecycle analysis, process management. • Internal innovation strategies for new processes and new business models. • Organizational structures and processes, management roles and responsibilities in multi-project environments.			
Teaching and learning methods			
The course is delivered as a distance course where the student works independently and computer-based; reads texts, writes essays, answers multiple choice questions and perform simpler calculations. The student will also have access to video lectures and other teaching materials.			
Prerequisites			
Basics on engineering and/or business			
Assessment methods			
Multiple choice questions.			

MC-P69: Small scale wind turbines

MC title	Small scale wind turbines		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 052	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6-7

Background of the proposed micro-credential

In the future electric grid, customers can earn extra income by agreeing to intermittent disconnections. Small-scale wind power serves as a valuable complement, especially in urban areas or buildings designed for islanding operation. Combined with solar PV generation and battery storage, this setup creates a reliable and sustainable energy solution. However, successful implementation relies on precise knowledge of the wind resource, understanding different small-scale wind turbine concepts, and maintenance considerations. By mastering these factors, stakeholders can fully harness the potential of small-scale wind power, contributing to a greener and more resilient energy future while actively participating in the energy transition.

Overview of the micro-credential

The course offers a comprehensive introduction to various small-scale wind turbine concepts, including vertical-axis and horizontal-axis wind turbines. Participants will explore the fundamental principles of energy conversion in these devices and learn how to estimate production using online tools at specific locations. The course also addresses important considerations such as the environmental impact, including noise and vibrations, as well as economic factors. Moreover, participants will gain insights into the robustness of small-scale wind systems when combined with other generation technologies.

Learning objectives

On the completion of the micro-credential, the learner will be able to:

- describe the energy conversion in relevant concepts for small-scale wind turbines.
- explain how small-scale wind turbines affect the local environment.
- evaluate the performance of a wind turbine with the help of the power curve and online wind resource characteristics.
- analyse the value of adding wind generation based on a specific context.

Table of contents

- History of small-scale wind turbines
- Vertical -xis wind turbines: working principles, Savonious turbines, Darriues turbines.
- Horizontal-axis wind turbines: working principles.
- Production calculation with the support of online tools
- Environmental impact
- System considerations

Teaching and learning methods

The course is delivered as a distance course where the student works independently and computer-based; reads texts, writes essays, answers multiple choice questions and perform simpler calculations. The student will also have access to video lectures and other teaching materials.

Prerequisites

Basics on engineering science

Assessment methods

Multiple choice questions.

MC-P70: Low temperature district heating

MC title	Low temperature district heating		
MC long title	-		
ISCED codes	*Primary*: 071	*Complementary*: 073	**ECTS:** 2.5
Suitable for	☒ STEM ☐ NON-STEM		**EQF level:** 6

Background of the proposed micro-credential

Heat recovery and renewable heat supply offer a unique opportunity to reduce overall resource demand significantly while promoting sustainability. By capturing waste heat from various sources and adopting renewable heat technologies, traditional fuels can be replaced effectively. This approach not only minimizes energy losses but also reduces greenhouse gas emissions, contributing to climate change mitigation. Embracing renewable heat sources like solar thermal, geothermal, and biomass fosters a cleaner energy mix, making strides towards a more sustainable future. Additionally, integrating these solutions leads to enhanced energy efficiency by decentralizing heat supply, reducing dependence on centralized systems, and cutting transmission losses. The implementation of heat recovery and renewable heat supply also stimulates economic growth through job creation and local economic revitalization

Overview of the micro-credential

This MC offers students a comprehensive understanding of low-temperature district heating systems from a holistic perspective. Exploring this infrastructure's benefits in establishing resource-efficient energy systems, the course emphasizes the increased utilization of renewable and recycled heat sources. By adopting such practices, resource demand intensity is reduced, leading to lower emissions and contributing to sustainability goals. Students will delve into various perspectives, including supply, distribution, user heat interface (substation), and end-user aspects, ensuring a well-rounded comprehension of low-temperature district heating's role in building a greener and more environmentally conscious energy landscape.

Learning objectives

On the completion of the micro-credential, the learner will be able to:

- describe the overall composition of a district heating system.
- problematize regarding the challenge of current system temperature levels in relation to potential introduction of more temperature sensitive heat supply and the necessity of lower temperature levels.
- discuss key issues regarding achieving lower temperature levels.

Table of contents

- General introduction to district heating systems
- Past, present, and future heat supply sources
- Temperature level dependency for different heat supply sources
- Temperature requirements of various sub-components of district heating systems
- Temperature errors in various sub-components of district heating systems

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, reading materials, individual tests.

Prerequisites

Basics in engineering science

Assessment methods

Multiple choice questions.

MC-P71: Gender mainstreaming and intersectionality

MC title	Gender mainstreaming and intersectionality		
MC long title	-		
ISCED codes	*Primary*: 031	*Complementary*: 041	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6

Background of the proposed micro-credential

The energy sector faces a pressing issue of gender diversity and imbalance, necessitating a move towards a more gender-inclusive industry. Boosting women's participation in the transition to renewable energy systems is critical. Research consistently highlights the positive impact of diversity on innovation and creativity, underscoring the need to promote inclusivity within the energy sector. By bridging the gender gap, the industry can access a broader talent pool and diverse perspectives, leading to more effective problem-solving and innovative solutions. Creating a gender-inclusive environment involves providing equal opportunities, supporting women's career growth, and challenging unconscious biases. A gender-inclusive energy sector is not only an equity imperative but also a strategic move to drive progress in sustainable energy. Embracing diversity unlocks the industry's full potential, paving the way for a more resilient and sustainable energy future.

Overview of the micro-credential

This MC places a strong emphasis on gender mainstreaming within the energy sector and aims to tackle the crucial issue of enhancing women's participation in the industry. Participants will delve into multifaceted strategies and approaches required to achieve greater gender equality and inclusivity within the sector. The course delves into identifying and understanding the barriers that hinder women's active involvement in the energy workforce. Societal norms, cultural stereotypes, limited opportunities, and ingrained biases are among the challenges explored. The course also explores the various drivers that can empower and encourage women to take on prominent roles in the energy sector. Supportive policies, mentorship programs, and gender-inclusive organizational practices are highlighted as catalysts for positive change. Moreover, participants will gain insights into the concept of intersectionality, recognizing that gender intersects with other social factors like race, ethnicity, class, and age, shaping women's unique experiences and opportunities in the industry.

Learning objectives

On the completion of the micro-credential, the learner will be able to:

- Understand basic concepts related to gender mainstreaming and intersectionality.
- Understand the relation between social constructions and barriers for women.
- Evaluate cases with both gender inclusive and gender exclusive behaviours and scenarios.

Table of contents

- What is gender mainstreaming?
- How can intersectional aspects help us to see new patterns for a diverse workforce?
- Social constructions as barriers or drivers?
- Gender inclusion – best practice

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, reading materials, individual tests.

Prerequisites

None

Assessment methods

Multiple choice questions.

MC-P72: Leadership development

MC title	Leadership development		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 031	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6

Background of the proposed micro-credential

Extensive research emphasizes the significance of robust leadership, particularly in cities, to effectively promote renewable energy adoption. Strong leadership is vital for initiating and driving sustainable initiatives, inspiring local actions, and fostering direct actions towards renewable energy integration. Moreover, building and utilizing social capital play a crucial role in facilitating the energy transition, enabling communities to collaborate, share resources, and collectively address energy challenges. In the context of leading communities or organizations, possessing effective leadership skills becomes essential in navigating the complex energy transition process. Leaders must possess the ability to communicate a compelling vision, engage stakeholders, and build partnerships to mobilize resources and support for renewable energy projects. Empowered with leadership skills, community leaders and organizational heads can play a pivotal role in guiding their constituents and members towards a greener and sustainable future.

Overview of the micro-credential

This MC focuses on developing individuals as leaders, covering both self-leadership and leading others. Participants will explore strategies for self-motivation, resilience, and goal achievement by addressing thought patterns and behavioural patterns. Additionally, the course delves into various leadership styles, behaviours, and the art of nudging to influence positive change among team members. By the end of the course, participants will possess a well-rounded skill set, empowering them to lead themselves effectively and guide others towards success within their organisations.

Learning objectives

On the completion of the micro-credential, the learner will be able to:

- Understand basic concepts related to self-leadership, leadership and social capital.
- Analyse their own self-leadership strategies.
- Understand different types of leadership styles and be able to choose between different styles.
- Understand the creation of leadership in terms of (i) the leader, (ii) the followers and (iii) the situation.

Table of contents

- Self- leadership principles
- Leadership in terms of (i) the leader, (ii) the follower and (iii) the situation
- Leadership and social capital
- Leadership styles and consequences of different leadership behaviours
- Leadership and nudging
- Leadership and promoting renewable energy in cities

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, reading materials, individual tests.

Prerequisites

None

Assessment methods

Multiple choice questions.
Group assignments.

MC-P73: Sustainable business models

MC title	Sustainable business models		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: 072	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6
Background of the proposed micro-credential			
The background of this topic involves the exploration and analysis of sustainable business models, with a particular focus on those applicable to renewable energy. These models aim to incorporate economic, environmental, and social considerations to ensure a holistic approach to business operations. The focus on renewable energy arises due to the growing importance of transitioning to cleaner and more sustainable energy sources. Understanding the unique challenges and opportunities in the renewable energy sector is essential for creating effective and impactful business models. Factors such as financing strategies, policy and regulatory frameworks, and stakeholder engagement play crucial roles in shaping sustainable business models for renewable energy ventures. By fostering innovation and aligning with sustainable development goals, these models contribute to building a greener and more sustainable future.			
Overview of the micro-credential			
This MC delves into sustainable and strategic approaches for organizations to develop effective and environmentally responsible business models and value creation. Participants will gain comprehensive knowledge of four crucial elements: value proposition, value creation and delivery, value capture, and value intention, all while considering the long-term sustainability of these models. Understanding the unique value a product or service offers, designing processes for delivery, generating revenue, and aligning organizational goals with sustainable strategic direction are key focal points. Real-world case studies and practical exercises empower participants to apply their knowledge, fostering the ability to innovate and strategize effectively within dynamic business environments while ensuring environmental stewardship.			
Learning objectives			
On the completion of the micro-credential, the learner will be able to: • Understand basic concepts related to sustainable business models. • Overall have knowledge about challenges (drivers, barriers) of business models for renewable energies. • Analyse and evaluate a sustainable business model.			
Table of contents			
• Business models; (i) value proposition, (ii) value creation and delivery, (iii) value capture and (iv) value intention. • Sustainable and circular business models • Challenges related to sustainable business models for renewable energies • Drivers and barriers of business models			
Teaching and learning methods			
The following teaching and learning methods will be used: • Video lectures, reading materials, individual tests.			
Prerequisites			
None			
Assessment methods			
Multiple choice questions. Group assignments.			

MC-P74: Bank financing of entrepreneurial firms

MC title	Bank financing of entrepreneurial firms		
MC long title	-		
ISCED codes	*Primary*: 041	*Complementary*: -	**ECTS:** 2.5
Suitable for	☐ STEM ☒ NON-STEM		**EQF level:** 6

Background of the proposed micro-credential

Bank funding is vital for sustainable development in economic, social, and environmental aspects. To remain competitive, banks must assess and monitor borrowing firms effectively, integrating sustainability criteria into their practices. Entrepreneurial firms seeking bank funding should prioritize sustainability to fuel growth. Understanding and mastering the credit process is essential for society, banks, and firms alike. Sustainable businesses thrive, contributing to a responsible economy. Banks become enablers of positive change, supporting ventures aligned with societal values. Collectively, the credit process drives a greener and more inclusive future.

Overview of the micro-credential

This course provides in-depth knowledge of the loan granting process of banks and the crucial bank-firm relationship. Participants will explore credit assessment, loan application evaluation, and financial management aspects. Emphasizing the impact of growing digitalization, the course delves into fintech advancements reshaping loan processing and enhancing efficiency in interactions between banks and firms. Furthermore, the course addresses the rising significance of sustainability and gender equality in financial decisions, considering the influence of societal demands. Environmental, social, and governance (ESG) factors are examined, shaping loan assessments in the current financial landscape. Additionally, participants will gain insights from international comparisons, analysing loan granting practices in diverse financial markets. This global perspective enables learners to navigate varied regulatory environments and cultural contexts.

Learning objectives

On the completion of the micro-credential, the learner will:

- gain knowledge and understanding of relevant theoretical concepts related to the bank's financing of entrepreneurial firms.
- develop theoretical and practical knowledge concerning the bank's financing of entrepreneurial firms.
- understand the decision process and credit management involved in bank loans.
- comprehend the effects of digitalization on the credit management process.
- recognize the significance of sustainability and equality considerations in credit management.

Table of contents

- The loan granting process of banks
- Assessment’s criteria
- The effects of digitalisation on the credit management of banks
- The importance of sustainability and equality considerations (corporate social responsibility)
- International comparisons

Teaching and learning methods

The following teaching and learning methods will be used:

- Video lectures, reading materials, individual tests.

Prerequisites

None

Assessment methods

Multiple choice questions.