EMISSION FREE EUROPEAN UNIVERSITIES

Strategic Development of Students' Sustainability Competencies:

Best Practices in Module Adoption, Transfer and Co-creation

Work Package #5

Student and Staff involvement – taking students and staff to universities´ emission neutrality

Co-funded by the
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BIP	Blended Intensive Program
CBL	Challenge Based Learning
CFP	Carbon Footprint: a measure of the Carbon Dioxide emissions released into the atmosphere by a particular person, organization, product, or activity (United Nations definition).
EFEU	Emission Free European Universities. The name of the ERASMUS+ project.
ETES	Enseigner les Transitions Écologiques et Sociales (Teaching Ecological and Social Transitions). The French Acronym of a 2-day large dedicated conference held in the University of Bordeaux (F) in July 2024.
ESD	Education for Sustainable Development.
ESE	Enjeux Sociaux et Environnementaux (Social and Environmental Challenges). The name of a MOOC created by UPHF in 2024 for the purpose of being massively taught to bachelor level students of UPHF (in French) and partially, for some specific sections, in EUNICE (in English).
EUNICE	European University for Customized Education. The European University Alliance, which UPHF joined in 2020, includes 10 European institutions and one associated partner from Morocco.
GSK	Glaxo Smith Kline
SDSR	Sustainable Development & Social Responsibility
TEDS	Transition Écologique pour un Développement Soutenable (Ecological Transition for a Sustainable Development). The name of a MOOC created and experimented by Université Grenoble Alpes, so as to massively train bachelor students and university teachers.
UVED	Université Virtuelle Environnement et Développement durable (Virtual University Environment & Sustainable development). A huge French online library of digital resources about sustainability, mainly videos.

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About this Publication

This publication introduces the main outcomes of the fifth work package “Student and Staff involvement – taking students and staff to universities´ emission neutrality” of the Erasmus+ Strategic Partnership project, "Emission Free European Universities" (EFEU).
This report is dedicated to activities within the scope of the fifth contractual work package (WP5) and the results achieved.

The activities conducted comprise:

- Activity 5.1: Digital lectures to reduce the carbon footprint
- Activity 5.2: Serious games for education purposes
- Activity 5.3: Conducting Summer School

Following expected project results were achieved within the activities:

- **Results Activity 5.1:**
  4 digital teaching units applying innovative teaching methods providing multiple teaching materials, available through the EFEU Project´s website www.dhbw-stuttgart.de/efeu
- **Results Activity 5.2:**
  one co-created EFEU serious game, piloted during the EFEU Summer School on 9th May 2025 in Stuttgart
- **Results Activity 5.3:**
  one co-created and implemented five-day summer school - EFEU Summer School conducted in Stuttgart, 5th -9th May 2025
- **Results Activity 5.4:**
  Following the EFEU dissemination plan, extensive dissemination measures reaching various stakeholder groups; reported in a separate dissemination log.
- **Results Activity 5.5:**
  A Transnational Project Meeting, conducted 7th & 8th May 2025, at DHBW Stuttgart, Germany.

As part of the work package, several dissemination activities have also been conducted, referring specifically to WP5 results but also to promote the whole project. The project´s dissemination activities are reported separately in the respective Work Package Report and Beneficiary Report sections.
The online version of this report can be obtained from the project’s website:
https://www.dhbw-stuttgart.de/efeu

1 Introduction

The transition to a low-carbon, low-energy, and resilient economy and society must mobilize all sectors of society more than ever. In higher education, students must be trained in socio-ecological issues and, a fortiori, in energy and climate issues. The engineer of the 21st century must be the driving force behind this ecological and energy transition. Whether they are decision-makers or technicians, they must and will have to integrate environmental issues into their choices and decisions, which are already impacting society. Therefore, students must be confronted with these issues from the time of their training.

The project aims to compare the points of view of 4 polytechnic universities covering Europe, from north to south and from east to west, to bring out a set of European best practices in terms of awareness-raising of various stakeholders training of HEI students, development of research, implementation of international cooperation, and, therefore, ultimately support the efficient and effective transfer of knowledge. Sustainable development and social responsibility will be at the heart of both the substance of the subjects dealt with and the form given to our actions. Efforts will focus on comparing practices, identifying and sharing the most successful ones, developing new practices, their joint experimentation, optimization, and international dissemination, particularly to the benefit of other European universities.

The project consortium is made up of four universities:

- the Baden-Württemberg Cooperative State University in Stuttgart (DHBW, Stuttgart, Germany) as project coordinator and represented by the Department of Industrial Engineering & Management and the Department of Electrical Engineering
- the Instituto Politécnico de Leiria (IPL, Leiria, Portugal), represented by the Departments of Mechanical Engineering and Environmental Engineering
- the Metropolia Ammattikorkeakoulu Oy (Metropolia UAS, Helsinki, Finland), represented by the Department of Real Estate and Building Services
- the Université Polytechnique Hauts-de-France (UPHF, Valenciennes, France), represented by the University's Institute of Technology (IUT) and by Valenciennes' National Institute of Applied Sciences in Hauts de France (INSA-HdF)

This report focusses on the work executed in close cooperation by the four partners within the scope of the fifth contractual work package (WP5) of the EFEU Project, dealing with the development of specific teaching activities, such as digital lectures, a ESD serious game, focusing on CO2 reduction and the development of a one-week summer school, to pilot developed deliverables and teaching formats.

2 Aims, deliverables and methodology of WP5

2.1 Aims of EFEU WP5

The objectives of WP5 are:

- to contribute to a reduction of the carbon footprint of teaching and learning by providing digital teaching formats (4 digital ESD focused lectures),
- to facilitate students´ and staffs´ involvement and to make virtual formats more beneficial by providing a gamification-based learning format/edugame (EFEU Serious Game),
- to enhance European collaboration, exchange and mobility by conducting a one-week summer school (EFEU Summer School 2025).

The original assumption that the carbon footprint of learning activities would be reduced by switching to online or hybrid formats must be qualified at this point! As the study of carbon emissions from three different formats in Activity 4.3 in Work Package 4 (see report EFEU_WP4_PartC_Act4.3_Carbon Footprint of Teaching.pdf) has shown, carbon emissions strongly depend on the individual conditions at the respective universities.

2.2 Deliverables expected from WP5

To achieve the work package's aims, the following three deliverables were proposed with the intention of being disseminated to a broad range of stakeholders.

- 4 digital teaching units applying innovative teaching methods and providing multiple teaching materials (**Activity 5.1)**
- one co-created serious game (**Activity 5.2)**
- one co-created and implemented five-day summer school (**Activity 5.3**)

Together, these results form a coherent set of outputs that strengthen sustainability competencies, foster innovative pedagogical approaches, and support the strategic objectives of both the EFEU project and Erasmus+ priorities.

<u>Digital Teaching Units (Activity 5.1)</u>

The four digital teaching units—*Sustainability in Management & Corporate Governance*, *Recycling e-Waste*, *Environmental Footprint of a Manufactured Product*, and *Life Cycle Assessment*—were designed and implemented collaboratively by the consortium partners.
Their contribution to the **overall EFEU project objectives** lies in:

- providing open-access, transferable resources that integrate sustainability into engineering curricula,
- reducing the carbon footprint of higher education by replacing traditional mobility-intensive lectures with digital formats, and
- strengthening the employability of students by equipping them with transversal skills urgently needed in industry.

For **WP5 specifically**, the digital units advance student and staff involvement by creating a shared pedagogical framework across institutions, enabling co-creation, and facilitating long-term integration into existing curricula.

In alignment with **Erasmus+ priorities**, these digital outputs demonstrate:

- **sustainability**, by embedding climate action and circular economy content;
- **digitalisation**, by leveraging online platforms for delivery and scalability; and
- **innovation in teaching**, by combining multimedia learning, case studies, and assessment tools to foster active, reflective learning.
-

Serious Game (Activity 5.2)

The co-created EFEU Serious Game, adapted from *Ma Terre en 180 Minutes*, introduces students and staff to immersive role-play scenarios in which they must collectively reduce carbon footprints.

In relation to the **overall project objectives**, the game exemplifies innovative teaching practices that raise awareness of the systemic nature of sustainability challenges and stimulate behavioural change. It also supports the wider goal of reducing the carbon footprint of academic activities by offering a scalable, digital-friendly alternative to resource-intensive workshops.

For **WP5**, the serious game engages students and staff as co-creators and active participants in developing and testing the tool. It empowers learners to reflect critically on their own practices, negotiate trade-offs, and develop action-oriented competencies, thereby deepening involvement in the university's emission neutrality strategy.

Aligned with **Erasmus+ priorities**, the game strengthens:

- **sustainability**, by modelling pathways for emission reduction;
- **digitalisation**, through its online and hybrid accessibility; and
- **innovation**, by introducing gamification and role-play as mainstream methods in engineering education.

Summer School (Activity 5.3)

The five-day EFEU Summer School brought together students and staff from across the consortium for an intensive programme combining master classes, challenge-based learning, design thinking workshops, and the pilot implementation of the serious game.

Its **contribution to the overall EFEU objectives** is evident in its role as a flagship event demonstrating interdisciplinary collaboration, cross-border exchange, and the practical application of sustainability competencies. It also served as a dissemination platform for other project outputs, ensuring visibility and long-term uptake.

For **WP5**, the summer school embodied the principle of active student and staff involvement. It provided a living laboratory for testing the digital lectures and serious game, while fostering international peer learning and reflection on the role of engineers in sustainable transformation.

Regarding **Erasmus+ priorities**, the summer school demonstrated:

- **sustainability**, by embedding ecological, social, and economic aspects in all activities;
- **digitalisation**, through the integration of online platforms and blended learning tools such as Padlet; and
- **innovation in teaching**, by piloting interdisciplinary, challenge-based, and experiential methods in a cross-cultural setting.

Result	Contribution to EFEU Objectives	Contribution to WP5	Alignment with Erasmus+ Priorities
4 Digital Teaching Units (Activity 5.1)	Integrate sustain-ability into enginee-ring curricula; reduce carbon footprint of teaching; provide transferable open-access resources.	Shared pedago-gical framework across institutions; co-created modules; long-term curricular integration.	Sustainability: embed climate/ circular economy content. Digitalisation: online platforms for delivery/scalability. Innovation: multimedia, case-based, active learning.
Serious Game (Activity 5.2)	Innovative teaching to raise awareness and stimulate behavioural change; reduce footprint of academic activities; scalable alternative to resource-intensive workshops.	Active involvement of students and staff in design and testing; empowerment through role-play and action-oriented learning.	Sustainability: model pathways for emission reduction. Digitalisation: online/hybrid accessibility. Innovation: gamification and role-play methods.
5-day Summer School (Activity 5.3)	Demonstrate interdisciplinary collaboration and cross-border exchange; practical application of sustainability competencies; dissemination of outputs.	Embodied student/staff engagement; tested digital lectures and serious game; fostered intercultural peer learning.	Sustainability: ecological, social, economic integration. Digitalisation: blended tools (e.g. Padlet). Innovation: challenge-based, experiential, interdisciplinary learning.

Table 1: WP5 Results Summary Table

Taken together, the three key results of WP5 constitute a coherent package that directly advances the **overall objectives of the EFEU project**—to integrate sustainability into engineering education and support universities on their path to emission neutrality—and the **specific objectives of WP5**—to engage students and staff through innovative, participatory, and digitally enabled teaching formats.

By aligning with the EU's strategic priorities of sustainability, digitalisation, and innovation in teaching, these outputs not only deliver immediate value within the EFEU consortium but also offer transferable models and resources for higher education institutions across Europe. They ensure that future engineers are equipped with the knowledge, skills, and mindsets necessary to act as leaders of the sustainable transformation of industry.

2.3 Applied Scientific Methods

The development of the four digital learning units within Work Package 5 (Activity 5.1) was grounded in a structured methodological approach that combined established research methods with innovative practices in higher education pedagogy. The overarching objective was to ensure scientific rigor, pedagogical relevance, and practical applicability in strengthening sustainability competencies of engineering students.

1. Literature Review and State-of-the-Art Analysis

The process began with a systematic review of current scientific literature and international best practices on education for sustainable development (ESD) in engineering disciplines. This ensured that the learning units reflected up-to-date knowledge in sustainability and were aligned with EU policy frameworks such as the European Green Deal and the Corporate Sustainability Reporting Directive (CSRD) (UNESCO, 2017; Lozano et al., 2017).

2. Needs Assessment and Surveys

Quantitative and qualitative surveys were conducted among students and academic staff across the partner institutions to identify gaps in existing curricula and to assess expectations regarding digital teaching formats. This needs analysis provided empirical evidence for the selection of topics and guided the formulation of specific learning outcomes (Thomas & Day, 2014).

3. Co-Creation Workshops

Participatory methods were applied through co-creation workshops that included lecturers, students, and, where appropriate, external experts from industry. This ensured a balance between scientific knowledge, pedagogical innovation, and professional relevance. The workshops followed design thinking principles to iteratively develop and refine content and structure (Bovill, 2020; Ramaswamy & Ozcan, 2018).

4. Action Research Approach

The development process followed an action research cycle of planning, implementation, observation, and reflection. Prototypes of the learning materials (videos, slides, and assessments) were produced, tested with student groups, and subsequently revised based on collected feedback. This iterative methodology allowed for continuous improvement and adaptation to learner needs (Kemmis et al., 2014).

5. Digital Learning Design and Multimedia Production

The instructional design of the modules applied established models such as constructive alignment and blended learning theory. Multimedia learning principles guided the production of videos and slide decks to enhance knowledge retention and engagement (Biggs & Tang, 2011; Mayer, 2014). Assessment tools were designed according to Bloom's taxonomy to address different cognitive levels, ranging from knowledge acquisition to critical reflection (Anderson & Krathwohl, 2001).

6. Evaluation and Peer Review

Pilot implementations of the units were systematically evaluated using mixed methods. Student feedback was collected through structured questionnaires and focus groups, while peer review among consortium partners ensured academic quality, coherence, and comparability across the four modules (Creswell & Plano Clark, 2017).

By combining these methods, the consortium ensured that the digital learning units not only met high academic standards but also reflected the collaborative and innovative spirit of the Erasmus+ programme. The applied methodology provided a robust foundation for developing transferable, scalable, and impactful educational resources that strengthen sustainability competencies in engineering education.

3 Activity 5.1: Digital Lectures to Reduce The Carbon Footprint

3.1 Co-creation of Digital Lectures

3.1.1 Needs Analysis and Goal Definition

The development of the four digital learning units was initiated with a structured needs analysis to ensure alignment with both the project’s objectives and the requirements of the Erasmus+ programme. Within the EFEU consortium, partner universities jointly assessed existing gaps in engineering curricula with regard to sustainability competencies. Internal surveys and consultations with teaching staff and students revealed a lack of systematic coverage of sustainability-related topics in engineering education, particularly in areas such as corporate governance, electronic waste recycling, product environmental footprints, and life cycle assessment.

In parallel, an external review of European higher education practices confirmed the growing demand for transversal sustainability skills, as reflected in the European Green Deal and the EU’s goal of climate neutrality by 2050. These findings guided the formulation of the four units, each addressing a critical sustainability challenge while remaining closely connected to engineering disciplines.

The project partners collectively agreed on the goals: to design digital modules that are academically rigorous, technologically accessible, and pedagogically engaging. The intended learning outcomes were defined as enabling students to critically reflect on sustainability challenges, to apply relevant analytical tools such as life cycle assessment, and to transfer these insights into their professional practice. This phase ensured that the developed learning units would not only enhance academic curricula but also prepare graduates to become active change agents for a sustainable industry and society.

3.1.2 Rationale for the Selection of Topics for the Four Digital Lectures under Activity 5.1

As part of Work Package 5, the EFEU consortium developed three interconnected strands of teaching innovation: digital lectures, a serious game, and an international summer school. Together, these activities aimed to engage students and staff in advancing universities’ transition to emission neutrality by combining flexible digital formats, experiential learning, and collaborative intercultural exchange. The four digital lectures developed under Activity 5.1 represent a cornerstone of this effort. They provide scientifically grounded, accessible resources that complement the interactive learning of the serious game and the intensive, interdisciplinary training of the summer school. In this way, the digital lectures not only stand as individual outputs but also serve as an integral part of a coherent pedagogical strategy to strengthen sustainability competencies among engineering students and staff across Europe.

Within Work Package 5 (Student and Staff Involvement), Activity 5.1 focused on the development of four digital lectures designed to foster sustainability competencies among engineering students. The selection of the topics (1) Sustainability in Management & Corporate Governance (DHBW), (2) Recycling e-Waste (UPHF), (3) Environmental Footprint of a Manufactured Product (IPL), and (4) Life Cycle Assessment (Metropolia) was based on a structured needs analysis and aligned with both the objectives of the EFEU project and broader EU sustainability priorities.

1. Sustainability in Management & Corporate Governance (DHBW)

This lecture addresses the integration of sustainability into decision-making structures, focusing on frameworks such as the Corporate Sustainability Reporting Directive (CSRD) and Environmental, Social and Governance (ESG) standards. For engineering students, understanding governance mechanisms is crucial, as engineers are increasingly expected to operate within regulatory and corporate frameworks that shape sustainable transformation. This topic links directly to the project's aim of preparing students as change agents who can embed sustainability not only in technical processes but also in institutional and corporate strategies.

Figure 1Digital Lecture: Sustainability in Management & Corporate Governance (DHBW)

2. Introduction to Recycling e-Waste (UPHF)

The exponential growth of electronic waste is one of the most pressing environmental challenges of industrial societies. Addressing this issue equips students with knowledge of material recovery processes, circular economy principles, and industrial symbiosis. For engineering education, the topic demonstrates how technical solutions can mitigate global waste streams while contributing to resource efficiency and carbon reduction. Its relevance lies in connecting sustainability with industrial practice, thereby strengthening the employability of graduates in emerging green sectors.

Figure 2: Digital Lecture: Introduction to Recycling e-Waste (UPHF)

3. Environmental Footprint of a Manufactured Product (IPL)

This lecture trains students to analyse and quantify the environmental impacts of industrial products across their life cycle. By focusing on product-level assessment, it links sustainability with core engineering tasks such as design, manufacturing, and process optimization. This unit supports the EFEU objective of integrating sustainability into everyday engineering practice, enabling students to understand trade-offs, identify hotspots for improvement, and design with a lower carbon footprint in mind.

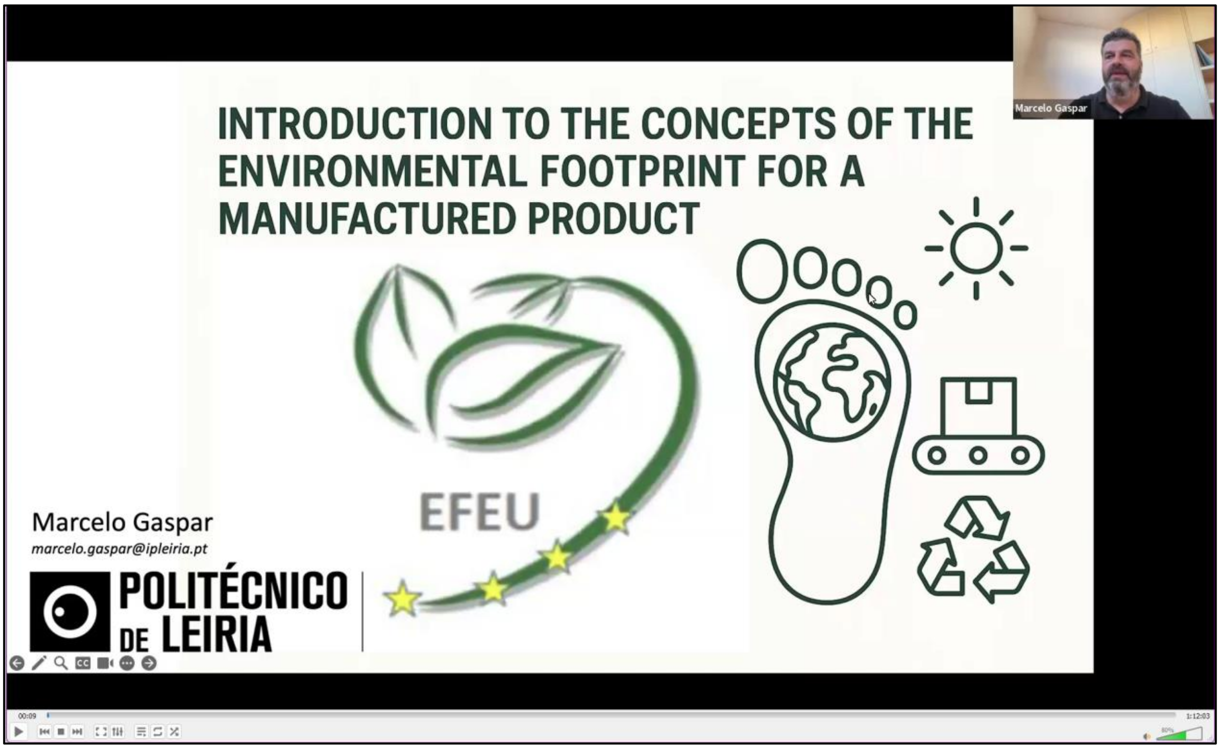

Figure 3: Digital Lecture: Environmental Footprint of a Manufactured Product (IPL)

4. Life Cycle Assessment (Metropolia)

Life Cycle Assessment (LCA) is a cornerstone methodology in sustainability science and industrial transformation. The inclusion of this topic ensures that students gain competence in internationally recognised tools for measuring environmental impact. LCA provides a methodological foundation that underpins the other three modules, thereby reinforcing systemic thinking and analytical skills. It enables students to compare design alternatives, assess energy and material flows, and evaluate the implications of different industrial choices.

Figure 4: Digital Lecture: Life Cycle Assessment (Metropolia)

Contribution to Project Objectives:

The digital lectures make a substantial contribution to the overall objectives of the EFEU project by:

- equipping engineering students with transversal sustainability skills directly relevant to the European Green Deal and the EU's climate neutrality targets for 2050,
- fostering innovative, digital teaching methods that reduce the carbon footprint of higher education by limiting the need for physical mobility, and
- providing transferable, open-access resources that can be adopted by universities beyond the consortium, ensuring impact at the European level.

For Work Package 5, the digital lectures specifically advance the goal of involving students and staff in the transition to emission-neutral universities by:

- offering accessible formats for engaging with sustainability irrespective of geographical location,
- strengthening the participation of both students and staff in co-created teaching activities, and
- piloting methods of digital learning that can be integrated into standard curricula.

Strategic Alignment and Added Value:

The digital teaching formats developed under Activity 5.1 align with EU and Erasmus+ strategic priorities in several ways:

- Sustainability: By addressing urgent challenges such as waste reduction, product footprints, and LCA, the lectures train engineers to act as leaders of the green transition.
- Digitalisation: The modules exemplify innovative use of digital media, combining videos, interactive slides, and online assessments. Their design reduces travel-related emissions and demonstrates the potential of online learning to contribute to universities' emission neutrality.
- Innovation in Teaching: Through co-creation workshops, participatory methods, and the integration of industry input, the lectures model new approaches to pedagogy that are both engaging and scalable across disciplines.
- International Dissemination and Scalability: Produced in English and openly licensed, the units can be shared within European university alliances (e.g. EU4DUAL, RUN-EU, EUNICE, U!REKA) and beyond, multiplying their impact.

The rationale for selecting the four topics rests on their capacity to address systemic industrial sustainability challenges while equipping engineering students with the competencies required to act as drivers of transformation. Together, the digital lectures provide a coherent, interdisciplinary set of resources that advance the EFEU project's dual mission: reducing the carbon footprint of higher education and strategically developing sustainability competencies in Europe's future engineers. By combining rigorous scientific content with innovative digital delivery, the lectures stand as a transferable model for integrating sustainability into engineering education at the European level.

3.1.3 Conceptual Design of the Learning Units

Following the needs analysis, the consortium entered the conceptual design phase. Each partner university assumed responsibility for one of the four digital modules, ensuring that the topics reflected their institutional expertise and research strengths. A joint framework was developed to guarantee coherence across all units. This framework defined learning objectives, structure, pedagogical approaches, and assessment formats.

The design of the units was grounded in the principles of Education for Sustainable Development (ESD) and followed a competency-based approach. Each module was structured into three components: (a) professionally produced learning videos providing theoretical input, (b) comprehensive slide decks to support individual study and classroom integration, and (c) digital assessments, including quizzes and reflection tasks, to evaluate student learning outcomes.

Pedagogically, the design was guided by active learning methods and the use of case studies. For example, the *Sustainability in Management and Corporate Governance* module introduced students to the Corporate Sustainability Reporting Directive (CSRD) and ESG standards, while the *Recycling e-Waste* module highlighted real industrial processes for material recovery. The *Environmental Footprint of a Manufactured Product* and *Life Cycle Assessment* units emphasized analytical tools that directly connect engineering decisions with environmental consequences.

By harmonizing structure and methodology, the conceptual design ensured consistency across the four learning units while leaving sufficient flexibility for contextualization by each partner.

3.1.4 Co-Creation and Collaborative Development

The co-creation process was a central characteristic of the EFEU approach. Development teams included academic staff from all four partner universities, student assistants, and, where relevant, external stakeholders from industry and sustainability organizations. This inclusive process reflected the Erasmus+ emphasis on participation, innovation, and knowledge exchange.

Each unit was co-developed through iterative workshops held online and during transnational project meetings. In these sessions, draft content, learning outcomes, and assessment tools were reviewed collectively. Students contributed by testing preliminary exercises and providing feedback on clarity, workload, and digital accessibility. Industry representatives offered input on practical relevance, ensuring that the modules would prepare students for real-world sustainability challenges.

The collaborative nature of the process facilitated mutual learning among partners. For example, DHBW Stuttgart shared its expertise in corporate governance frameworks, while UPHF brought experience in recycling systems. IPL contributed its knowledge of product environmental analysis, and Metropolia enriched the design with its expertise in life cycle assessment and sustainable construction practices.

This co-creation approach not only improved the academic quality of the materials but also created a strong sense of ownership and commitment among all partners, enhancing the long-term sustainability and transferability of the units.

3.1.5 Digital Implementation

The implementation phase translated the conceptual design into high-quality digital resources. Each partner produced professional learning videos, supported by academic staff and technical teams. These videos were recorded in English to enable broad international dissemination, with subtitles provided to ensure accessibility. Visual elements such as diagrams, animations, and real-life examples were incorporated to increase learner engagement.

Slide decks were developed to complement the videos, providing structured summaries, key definitions, and illustrative case studies. These materials were designed to be reused in both digital and classroom-based teaching, thereby enhancing flexibility.

Assessment components were integrated into a digital learning environment. Online quizzes, reflective assignments, and case-based questions allowed students to test their knowledge and receive immediate feedback. The design emphasized formative learning: students were encouraged to engage with the content repeatedly and from different perspectives.

Throughout the implementation, attention was given to digital inclusivity and sustainability. The materials were hosted on platforms that require minimal energy and bandwidth, making them accessible to students with limited technical resources. Moreover, by replacing physical teaching formats with digital alternatives, the modules contributed directly to the project's aim of reducing the carbon footprint of higher education.

3.1.6 Pilot Testing and Collection of Feedback

Before formal integration into curricula, all four learning units underwent a pilot phase. Students from the partner universities were invited to test the modules in real teaching settings. Pilot sessions were embedded into existing courses or offered as supplementary learning opportunities.

Feedback was collected through structured surveys, focus group discussions, and direct observation by teaching staff. Students evaluated the clarity and structure of the videos, the comprehensibility of the slide decks, and the fairness and relevance of the assessment tasks. They also commented on technical aspects such as user-friendliness and accessibility across different devices.

The evaluation revealed a high level of acceptance and motivation among students. In particular, the use of real-world examples and the modular design were praised. At the same time, constructive feedback was collected to improve user experience. For instance, students requested clearer guidance on the expected workload and more interactive elements within the videos.

This systematic evaluation ensured that the units met the standards of quality and relevance required by both the Erasmus+ programme and the participating universities. The feedback also provided valuable insights for refining the modules before their official release.

3.1.7 Refinement and Finalization

Based on the pilot testing results, the consortium refined the content, structure, and digital tools of the four learning units. Adjustments included improving the pacing of the videos, enhancing visual elements in the slides, and clarifying instructions for the assessments. In some cases, additional examples and case studies were added to strengthen the practical relevance.

Technical improvements were also made to ensure smooth functionality across different platforms. Accessibility features such as subtitles and downloadable PDF versions of the slides were standardized. Furthermore, the assessment tools were calibrated to align with the European Credit Transfer and Accumulation System (ECTS) requirements, thereby facilitating formal integration into study programmes.

Final versions of the units were peer-reviewed within the consortium. Each partner university reviewed the modules developed by another institution to ensure consistency, quality, and coherence. This mutual review process strengthened academic credibility and demonstrated the collaborative spirit of the project.

The finalized learning units represent a shared intellectual output of the consortium, combining academic expertise, student feedback, and digital innovation. They are ready for long-term use within the partner institutions and for dissemination to other higher education providers across Europe.

3.1.8 Dissemination and Integration into Curricula

The last step of the process focused on dissemination and integration. The four digital learning units were **published on the project's website only (www.dhbw-stuttgart.de/efeu)** and shared through partner universities' digital learning platforms. They are freely available for academic use under a Creative Commons licence, reflecting the Erasmus+ principles of openness and knowledge sharing.

Integration into curricula was ensured by embedding the units into existing engineering programmes at the four partner universities. For example, the *Sustainability in Management* *and Corporate Governance* unit was integrated into business engineering modules at DHBW Stuttgart, while the *Life Cycle Assessment* unit was included in environmental engineering courses at Metropolia. UPHF incorporated the *Recycling e-Waste* module into its industrial engineering programme, and IPL integrated the *Environmental Footprint of a Manufactured Product* unit into mechanical engineering courses.

Beyond the consortium, dissemination activities included multiplier events, conference presentations, and publications in academic networks. The availability of high-quality digital resources in English has also enabled other institutions within European university alliances (such as U!REKA, RUN-EU, EU4DUAL, and EUNICE) to adopt and adapt the modules.

Through these measures, the learning units not only strengthened sustainability competencies within the participating universities but also contributed to a broader European effort to modernize engineering education and support the transition towards emission-free universities.

Co-funded by the Erasmus+ Programme of the European Union

3.2 The four EFEU Digital Lectures

The digital lectures are provided through the project´s homepage www.dhbw-stuttgart.de/efeu. The following sections briefly present the syllabus of each digital teaching unit and lists downloadable resources from the website. The four modules represent a further development of four face-to-face events presented in work package 4.

3.2.1 Sustainability in Management & Corporate Governance (DHBW)

Coordinating University: Baden-Wuerttemberg Cooperative State University Stuttgart (DHBW Stuttgart), Germany

Degree: Master/Bachelor

Year	Semester	Contact Hours	Workload	ECTS
suitable for all years, with no pre-requisites	suitable for all semester	3h	30h	1

Coordinating Lecturer: Prof. Dr. Klaus Homann, klaus.homann@dhbw-stuttgart.de

Teaching Staff: Prof. Dr. Christian Götz, Prof. Dr. Klaus Homann

Course Description

This module provides an in-depth understanding of ESG (Environmental, Social, and Governance) regulations and their impact on corporate governance. It explores key regulatory frameworks, disclosure requirements, and the challenges of ESG implementation. The module focuses on the Corporate Sustainability Reporting Directive (CSRD), the European Sustainability Reporting Standards (ESRS), the EU-Taxonomy. Additionally, the history of ESG, the development of ESG reporting, and the concept of green investments will be covered. Slides describing the online lecture are given in the annex A.

Learning Objectives

Students will gain knowledge of European ESG standards and their impact on corporate governance. They will explore key ESG principles and understand the role of regulation in promoting corporate sustainability. The course will enable students to compare major ESG regulatory frameworks, including CSRD, ESRS, and the EU Taxonomy. Additionally, they will assess ESG reporting requirements and compliance mechanisms, evaluating their influence on corporate decision-making. By the end of the module, students will be able to develop strategic recommendations for effectively integrating ESG principles into business operations.

Syllabus

This teaching unit consists of three learning units:

1. Introduction: Why ESG Matters
2. Corporate sustainability reporting directive (CSRD) and European Sustainability Reporting Standards (ESRS)
3. Best Practices in Corporate Sustainability Reporting – Strategy, Road Map, Case Studies

Teaching Methodologies

The course is offered as web-based learning or in-person seminar providing digital course materials, such as pre-recorded lectures and academic literature. It consists of three separate learning units, each with a workload of 10 hours. Students will work independently according to the provided schedule.

Assessment

Students will have assignments that they will share with others. Mutual feedback is required to progress through the course. Assessment through a final Quiz test made online by the students.

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3.2.2 Recycling e-Waste (UPHF)

Coordinating University: UPHF Université Polytechnique Hauts de France, Valenciennes, France

Degree: Master/Bachelor

Year	Semester	Contact Hours	Workload	ECTS
suitable for all years, with no pre-requisites	suitable for all semester	3h	30h	1

Coordinating Lecturer: El Hadj Dogheche, elhadj.dogheche@uphf.fr

Teaching Staff: El Hadj Dogheche et al.

Course Description

This course introduces students to the fundamental concepts of materials recycling for electronic sector. The teaching unit is focusing the growth rate and the technical issues for electrical waste as well as the international regulations. It includes the presentation of existing and the near future solutions for e-waste reduction. In this course, the learner will be confronted with the problems that our planet faces as a result of our consumption and will understand the health and the environmental issues related to e-waste expansion. A secured process of recycling is actually a key solution for reducing the carbon footprint into industrial processes production. Slides describing the online lecture are given in the annex A

Learning Objectives

The objectives of the teaching unit are related to the growth rate and the technical issues for electrical waste as well as the international regulations. It includes the presentation of existing and the near future solutions for e-waste reduction. In this course, the learner will be confronted with the problems that our planet faces as a result of our consumption and will understand the health and the environmental issues related to e-waste expansion. A secured process of recycling is actually a key solution for reducing the carbon footprint into industrial processes production.

1. **Understand the Concept of Electrical Waste**
   - Define electrical and electronic waste (e-waste) and recognize its importance as a global environmental challenge.
   - Identify common types of electrical waste and their environmental and health impacts when improperly managed.

2. **Explore E-Waste Regulations and Policies**
   - Understand international frameworks, such as the Basel Convention and EU WEEE Directive, governing e-waste management.

- Analyze national and regional laws concerning e-waste recycling, including producer responsibility and waste disposal standards.
- Examine the role of regulatory compliance in fostering sustainable recycling practices.

3. **Learn E-Waste Collection and Sorting Processes**
   - Identify methods and technologies used in the collection and categorization of electrical waste.
   - Discuss the significance of proper waste sorting in optimizing recycling efficiency and reducing contamination.

4. **Examine Recycling Technologies for E-Waste**
   - Gain an overview of mechanical, chemical, and thermal processes used in recycling electronic waste.
   - Explore cutting-edge technologies, such as hydrometallurgy, pyrometallurgy, and bioleaching, in recovering valuable materials like rare earth metals.
   - Evaluate the benefits and limitations of different recycling methods.

5. **Understand the Role of Circular Economy in E-Waste**
   - Learn how e-waste recycling contributes to the circular economy by reclaiming valuable resources and minimizing landfill dependency.
   - Discuss opportunities for reuse, refurbishment, and remanufacturing of electronics to extend product lifecycles.

6. **Develop Awareness of Environmental and Social Impacts**
   - Assess the environmental consequences of improper e-waste handling, including pollution and resource depletion.
   - Recognize the social implications, such as the health and safety of informal recyclers and community impacts.

7. **Engage with Industry and Technological Trends**
   - Investigate emerging trends in e-waste recycling technologies, including robotics and AI in automated sorting.
   - Understand the role of innovation and private-sector initiatives in addressing e-waste challenges.

8. **Apply Practical Knowledge in E-Waste Management**
   - Design a basic e-waste recycling plan considering regulatory, technological, and economic factors.
   - Analyze case studies of successful e-waste recycling programs to identify best practices and lessons learned.

Syllabus

1. Legal Definition of electrical Waste and International Regulations
2. Responsibility from Consumers to Producers
3. Key perspectives for efficient for e waste recovery and recycling

Teaching Methodologies

One 3-hour seminar conveyed synchronous/ asynchronous teaching using digital course material

Assessment

Assessment through a final study case with oral presentation or a Quiz test made online by the students.

Bibliography

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3.2.3 Environmental Footprint of a Manufactured Product (IPL)

Coordinating University: UPHF Université Polytechnique Hauts de France, Valenciennes, France

Degree: Master/Bachelor

Year	Semester	Contact Hours	Workload	ECTS
suitable for all years, with no pre-requisites	suitable for all semester	3h	30h	1

Coordinating Lecturer: El Hadj Dogheche, elhadj.dogheche@uphf.fr

Teaching Staff: Loic Lezzani

Course Description

This course highlights the problems that our planet faces as a result of our consumption and will understand the environmental processes involved in the production of a product and the concepts of environmental footprint concerned. The "Environmental footprint and eco-design" typically falls under the domain of sustainability engineering, focusing on methods to measure and mitigate environmental impacts of products and services through eco-conscious design practices. Slides describing the online lecture are given in the annex A.

Learning Objectives

*1-**Introduction to*** **Sustainable Production**

- Introduction to, background and standards
- Lice Cycle Assessment (LCA) theory
- Requirements for Sustainability

*2- **Environmental footprint and eco-design***

- How to carry out an eco-design: SIMAPRO software application
- Sustainable Design
- Environmental Foot Print

3- multi-criteria analysis

Ecological Impact

- Resource Management
- Waste Reduction
- Energy Efficiency
- Environmental innovation

Syllabus

1- Understanding what design entails

2- Be aware of the environmental impacts during product development
3- Applying the eco-design analysis approach

Teaching Methodologies

One 3-hour seminar conveyed synchronous/ asynchronous teaching using digital course material

Assessment

Assessment through a small “surpriseness report”. Write half a page or less to express what surprised me in this lecture?

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3.2.4 Life Cycle Assessment (Meropolia)

Coordinating University: Metropolia University of Applied Sciences, Helsinki

Degree: Master/Bachelor

Year	Semester	Contact Hours	Workload	ECTS
suitable for all years, with no pre-requisites	suitable for all semester	3h	30h	1

Coordinating Lecturer: Sergio Rossi, sergior@metropolia.fi

Teaching Staff: Sergio Rossi

Course Description

This course introduces students to the fundamental concepts and methodologies of Life Cycle Assessment (LCA). LCA is a tool used to assess the environmental impacts of products and systems throughout their entire life cycle, from raw material extraction to disposal. The course covers the four main phases of LCA: goal and scope definition, life cycle inventory, life cycle impact assessment, and interpretation. Students will learn how to apply LCA to various products and systems, and understand its importance in sustainable development. Slides describing the online lecture are given in the annex A.

Learning Objectives

1. Understand the principles and methodology of Life Cycle Assessment.
2. Learn about the history and development of LCA, including why it was introduced.
3. Understand the four stages of an LCA:
    a. Goal and scope definition,
    b. Inventory analysis,
    c. Impact assessment,
    d. Interpretation of the results and recommendation.
4. Apply LCA to real-world case studies in various sectors.

Syllabus

- Life Cycle Assessment
- life cycle inventory, life cycle impact assessment

Teaching Methodologies

The course is offered in the form of a web course, students will work independently according to the given schedule. The learning material is mainly in the form of videos, readings and individual assignments which will be shared with other students. A 1,5-hour interactive, online seminar will follow the individual study part.

Assessment

Assessment through a final Quiz test made online by the students. The students will have one week after the interactive seminar to complete the Quiz test.

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4 Activity 5.2 - Serious Games for Education Purposes

> “The prevalence of games in our culture provides an opportunity to increase the understanding of our global challenges” (Gratiot et. Aa. , 2023).

In the context of WP3, various methods of playful learning have already been discussed in detail. The development of the EFEU Serious Game is based on these principles, which will first be outlined below.

This will be followed by a presentation of the development of the role-playing game, as well as its piloting and evaluation within the framework of the EFEU Summer School 2025.

4.1 Interactive activities: role-playing games

Role-playing games are comparable to Fresk workshops in their playfulness, but also to challenges, in that there can be implicit competition between game sessions organized asynchronously in small groups, with each team aiming to beat the previous record. The special feature of a role-playing game is that each participant doesn't embody himself, but rather a character assigned to him at the start of the game, with his talents and faults, powers and weaknesses, and various attributes (e.g., his carbon footprint).

“Ma Terre en 180 minutes” (Literally: “My Earth explained in 180 minutes”) is the 1st collaborative workshop from the academic world to build realistic scenarios for reducing one's carbon footprint. The game’s logo is shown in Figure 5.

Figure 5: “Ma Terre en 180 minutes” role-playing game logo

Based on the observation that almost two-thirds of carbon emissions from research laboratories are directly linked to staff activities (airplanes, intensive calculations, etc.), a group of professional academic researchers (F. Giraud, N. Gratiot, B. Hingray, F. Michau, G. Panthou, and G. Sarret) considered the following question: “How can we make the scientific community aware of the need to reduce our carbon footprint, and collectively think about alternatives to airplanes?” To tackle these questions in a fun and friendly way, the game creators have created a collaborative workshop. The workshop is designed for in-person activity but can also be played online. It features research teams from different fields. Each player takes on the role of a member of a research team. The collective goal is to reduce the institution's GHG emissions by 50%. However, not everyone shares the same vision of the urgency of changing practices, nor the same propensity to do so. Lively debates are consequently expected!

In a scientific article published in OpenScience in Feb. 2022, the authors explain the game principle: “after building a common scientific background about the context (global warming, its causes and consequences) and challenge (50% reduction of our carbon budget by 2030), the role-playing participants immerse themselves into fictional characters, to simulate the behavior of a real research group.” Figure 6 showcases how a typical game session unfolds.

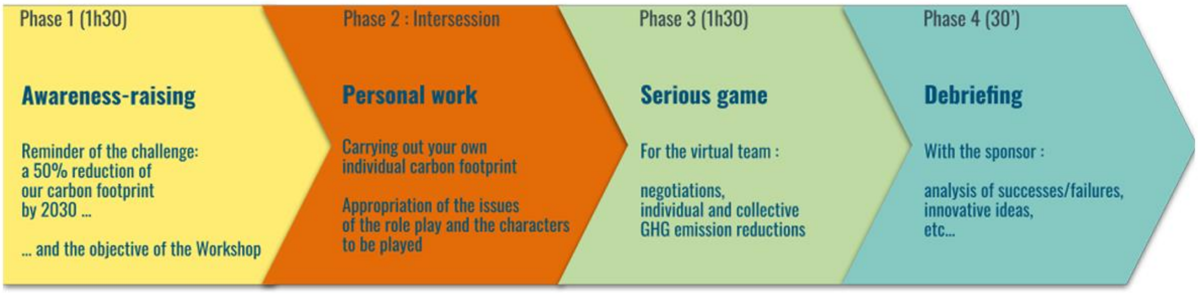

Figure 6: "Ma Terre en 180 minutes" role-playing game course

The first phase may be shortened if the audience is already aware of the central issue. The digital interface, as demonstrated in Figure 7, is shown to the participants by the facilitator. In the middle, the tokens represent the contributors to the collective CFP of different practices, which can be replaced by other practices or abandoned. The radius of the disk is proportional to the GES emission in tons $CO2_{eq}$. Their color represents the character who is responsible for this emission. The players can try to convince each other, through negotiation, to drop their token in the area of renunciation (in the right column) and replace it with some alternative tokens picked up from the bank of possibilities (in the left column).

Figure 7: "Ma Terre en 180 minutes" role-playing game digital board

Several variants (with various roles and types of tokens) of the same game are proposed in "Ma Terre" online portal, reflecting the diverse situations observed in various research laboratories, including climatology, geophysics, earth dynamics, environment and climate, ocean and climate, water resources, and Antarctica.

Co-funded by the Erasmus+ Programme of the European Union

4.2 The EFEU Serious Game: Role-Play as a Catalyst for Sustainability Competencies

4.2.1 Introduction: Role-Play as a Pedagogical Tool

Role-playing games have long been recognised as a powerful educational method that allows learners to engage actively with complex societal challenges. Unlike traditional didactic teaching formats, role-play enables participants to assume perspectives beyond their own, fostering empathy, systems thinking, and collaborative problem-solving (Kolb, 2015; Meadows, 2008). In the context of higher education, and particularly in engineering disciplines, role-play simulations represent an innovative approach to addressing sustainability issues that are inherently interdisciplinary and require collective action. Within the EFEU project, the development of the *EFEU Serious Game* demonstrates the capacity of this method to connect abstract sustainability goals with concrete behavioural changes, while simultaneously enhancing international collaboration and digital teaching innovation (Gee, 2007; Squire, 2011).

The EFEU serious game is an engaging and interactive learning tool with strong potential for broad, international dissemination. Its playful format makes it more accessible and memorable for students. The game can be easily shared, adapted, and reused across different educational contexts at no cost, supporting long-term impact and continuity beyond the EFEU project. By combining serious content with a fun, participatory approach, it fosters deeper learning, critical thinking, and collaboration across diverse audiences on the issue of climate change and actions that can be taken to address this phenomenon.

4.2.2 Special Features of Role-Playing Games in Sustainability Education

The pedagogical strength of role-playing games lies in their immersive and experiential nature. Participants do not remain passive recipients of information but actively shape outcomes through their decisions, negotiations, and strategies (Barab et al., 2010). This feature is particularly relevant for sustainability education, where learners must navigate trade-offs between ecological, social, and economic dimensions (Lozano et al., 2017).

Role-playing games create a safe yet realistic environment in which students can test the consequences of decisions, explore conflicting stakeholder interests, and learn from both success and failure (Arnab et al., 2015; Wouters et al., 2013). Such experiential learning mirrors the complexity of real-world sustainability challenges and prepares students to transfer these insights into professional engineering practice. The *EFEU Serious Game* integrates this approach by simulating carbon-reduction decisions, making visible the links between individual choices and collective climate goals.

4.2.3 Suitability of Role-Play for Behavioural Change and CO_2 Reduction

A central innovation of the *EFEU Serious Game* is its explicit focus on fostering behavioural change toward climate-friendly actions. The game design challenges players to reduce individual carbon footprints by up to 50%, encouraging them to reflect on the consequences of mobility choices, consumption habits, and energy use.

The suitability of role-play for behavioural change lies in its ability to combine cognitive and emotional engagement. By embodying roles—such as students, staff members, or professionals with diverse lifestyles—participants experience the tension between personal convenience, institutional constraints, and planetary boundaries (Aldrich, 2009). The negotiation phase of the game reinforces the need for cooperation and compromise, highlighting that ambitious emission reductions are only achievable through coordinated action (Redclift & Benton, 2018). This immersive process enhances awareness and motivates players to adopt climate-conscious practices beyond the game setting (Sauvé, 2010).

4.2.4 The EFEU Serious Game: Objectives and Design Principles

The *EFEU Serious Game* was conceived as part of Work Package 5, Activity 5.3, with the objective of strengthening sustainability competencies among engineering students across Europe. Its design was guided by three principles:

1. **Action Orientation** – encouraging players to explore practical pathways for reducing emissions.
2. **Systems Perspective** – linking individual behaviour to broader institutional and societal structures (Meadows, 2008).
3. **Collaborative Learning** – fostering peer-to-peer exchange and collective problem-solving (Wiek et al., 2011).

By combining these principles, the game advances key sustainability competencies: critical thinking, future-oriented reasoning, values-based decision-making, and action competence (Wiek et al., 2011). It also supports transversal skills such as negotiation, teamwork, and intercultural communication—competencies highly relevant for the future professional life of engineers (Lozano et al., 2017).

4.2.5 European Collaboration and Partner Contributions

The co-creation of the *EFEU Serious Game* illustrates the strength of European and international collaboration. Each of the four partner universities contributed specific expertise to the development process:

- **DHBW Stuttgart (Germany)** coordinated the overall development and ensured alignment with the project's pedagogical strategy.
- **Université Polytechnique Hauts-de-France (France)** introduced and adapted the original role-play concept "Ma Terre en 180 minutes," providing methodological expertise and facilitating contacts with the game's creators.
- **Instituto Politécnico de Leiria (Portugal)** contributed case studies and examples related to product footprints and sustainable practices in engineering education.
- **Metropolia University of Applied Sciences (Finland)** enriched the design with experience in digital learning formats and sustainability assessment methods.

This collaborative approach was supported by regular online workshops and transnational project meetings, ensuring iterative co-design, mutual feedback, and shared ownership. Students were actively involved in pilot phases, providing valuable insights into usability and learning impact, consistent with participatory co-creation approaches in higher education (Bovill, 2020). The outcome is a game that reflects diverse cultural perspectives and institutional contexts, increasing its transferability across Europe.

4.2.6 Alignment with Erasmus+ Objectives

The development and implementation of the *EFEU Serious Game* align closely with the strategic objectives of Erasmus+:

- **Digitalisation**: The game is accessible in both physical and digital formats, enabling wide dissemination and use across different learning environments (Arnab et al., 2015).
- **Innovation in Teaching**: By integrating role-play into engineering education, the project pioneers new pedagogical approaches that move beyond traditional lecture-based instruction (Squire, 2011).
- **Sustainability**: The game directly addresses climate action by engaging students in reducing carbon emissions and fostering long-term behavioural change (Wiek et al., 2011).
- **Internationalisation**: The co-creation process demonstrated how cross-border collaboration enhances quality, creativity, and relevance in higher education outputs (Lozano et al., 2017).

Through this alignment, the *EFEU Serious Game* represents not only an intellectual output of the consortium but also a contribution to the broader European agenda of sustainable, innovative, and digitally enhanced higher education.

4.2.7 Conclusion and Outlook

The *EFEU Serious Game* demonstrates the transformative potential of role-playing methods in higher education for sustainability. By immersing students in decision-making processes that directly reflect the complexity of climate challenges, the game bridges the gap between abstract knowledge and practical action (Barab et al., 2010). It empowers engineering students to critically evaluate their own behaviours, to collaborate across disciplines and cultures, and to envision alternative pathways towards emission reduction.

Looking ahead, the partners plan to refine the digital interface, expand the range of scenarios, and embed the game more deeply into teaching curricula. Moreover, its open-access availability ensures that universities beyond the EFEU consortium can adopt and adapt the game. In this way, the *EFEU Serious Game* contributes to the long-term impact of the project, supporting the transition towards emission-free European universities and equipping the next generation of engineers with the competencies needed to lead this transformation (Wiek et al., 2011; Sauvé, 2010).

4.3 Genesis and Development of the EFEU Serious Game

Starting Point:

During the second Transnational Project Meeting (TPM) in Valenciennes, the UPHF team introduced the serious game “Ma Terre en 180 minutes” as a potential foundation for adaptation within the EFEU project, thereby reducing the need to develop a new tool from the ground up. Originally developed in 2022 by scholars from the University of Grenoble Alpes (UGA), the game demonstrates strategies that can reduce the carbon footprint (CFP) of typical research laboratories by up to 50%.

The development team at UGA (F. Giraud, N. Gratiot, B. Hingray, F. Michau, G. Panthou, and G. Sarret) formulated the central guiding question:

“How can the scientific community be sensitized to the necessity of reducing its carbon footprint, and how can viable alternatives to air travel be collectively identified?”

In contrast to the *Climate Fresk*, *Ma Terre* emphasizes both awareness and action by fostering the co-construction of solutions. Its format situates participants within a familiar institutional context, assigns clearly defined roles, and integrates digital functionalities such as session recording, historical comparisons, and identification of best practices.

To facilitate structured knowledge transfer, a UPHF partner trained in the “Ma Terre” methodology presented the tool to the consortium. This demonstration aimed to highlight its potential and initiate discussions on its adaptation to the EFEU objectives.

In June 2024, the consortium established direct contact with the game’s founders, in particular Nicolas Gratiot, to assess which variant of the tool (e.g., research laboratories, secondary schools, or institutional pilot projects with Sciences Po Grenoble) best aligns with the EFEU project's scope.

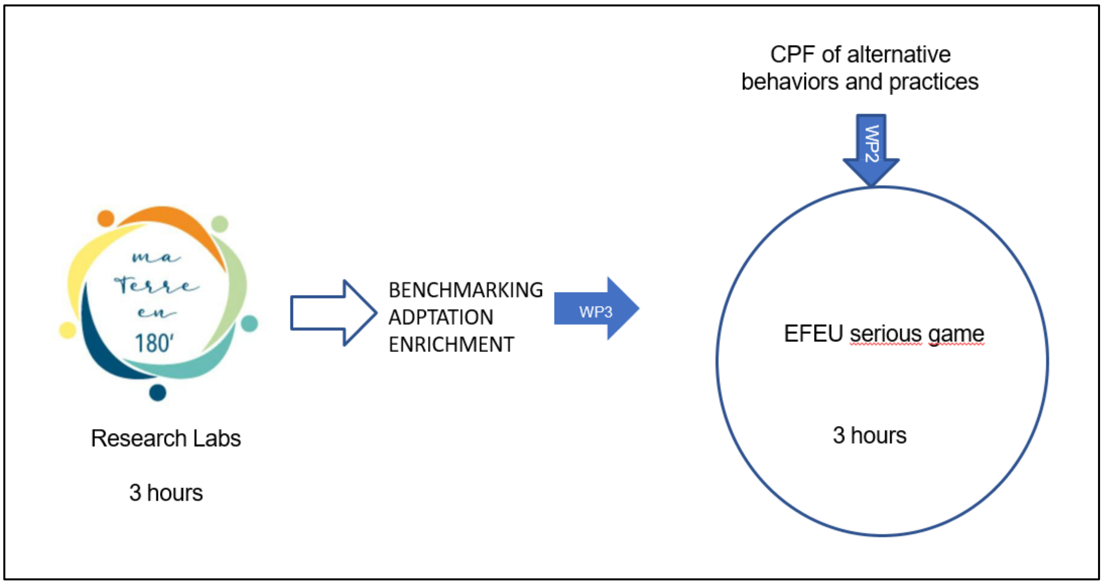

Figure 8: EFEU Serious Game – Design Thinking

Taking into account the specific requirements of the EFEU project and in alignment with the recommendations provided by the game's creators, the consortium decided to adapt and further develop the Labs version of "Ma Terre". This version was identified as the most suitable basis for customization and enhancement in order to meet the project's objectives.

Milestone Development:

The implementation of the serious game was formally initiated with the presentation of the project roadmap, scheduled as a milestone on 10 October 2024. This milestone marked the official launch of the development phase. To ensure structured monitoring and iterative refinement, monthly coordination meetings were established as recurring governance mechanisms.

At the conclusion of the kick-off meeting, each consortium partner was required to nominate a designated representative, thereby establishing the governance body responsible for the co-creation process under the leadership of UPHF. The core deliverable of this body is the progressive design and adaptation of the game in alignment with the project objectives.

The roadmap (Figure 9) was defined as a living document and systematically updated during each monthly meeting to reflect achieved deliverables, integration of partner feedback, and adjustments to subsequent milestones.

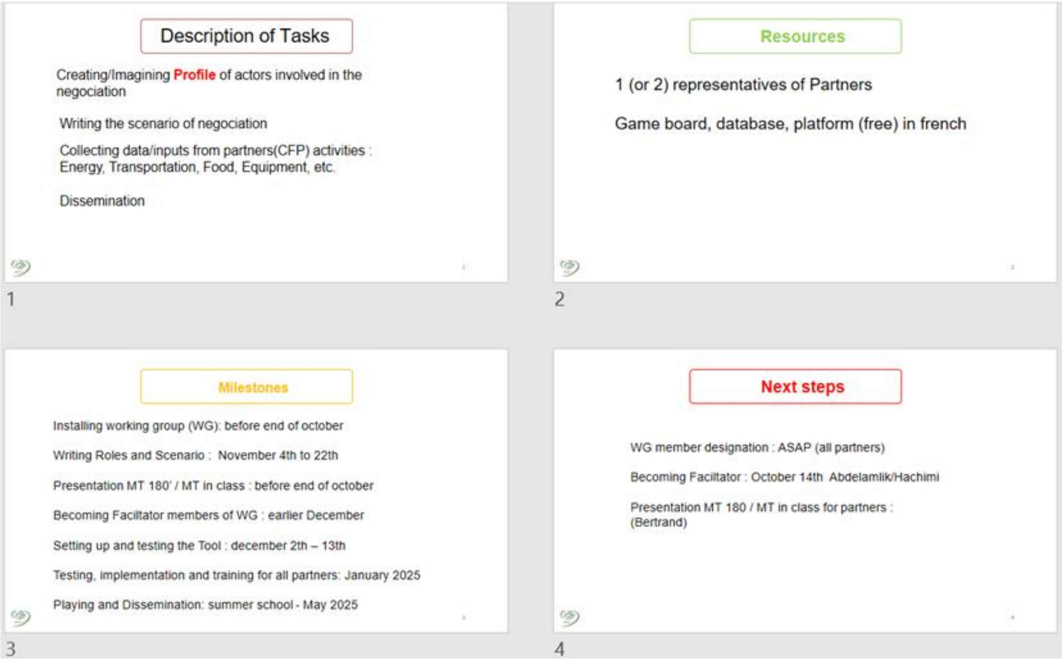

Figure 9: EFEU Serious Game - Road Map

Monthly coordination meetings function as a governance and quality assurance mechanism. At each meeting, the roadmap is updated to:

- reflect achieved deliverables,
- document feedback from partner institutions,
- realign subsequent milestones with emerging project needs.

<u>UPHF “Ma Terre” Workshop for Project Partners:</u>

The *“Ma Terre” tool, developed by the University of Grenoble Alpes, was presented by a UPHF partner previously trained in its methodology (Figure 10. The objective of this presentation was to provide consortium partners with an informed understanding of the tool’s potential and to initiate discussions on how it could be adapted to the objectives and framework of the EFEU project.

Figure 10: UPHF “Ma Terre” Workshop

Creation of a Dedicated Game Board Workspace for EFEU:

The tool provides extensive opportunities for customization. Accordingly, a dedicated workspace has been established for the EFEU project, enabling the integration of project-specific characters and scenarios. Access to this customized game board is facilitated through a shared key, ensuring that all partners are able to participate in the co-creation process and contribute to the iterative development of the adapted game version (Figure 11).

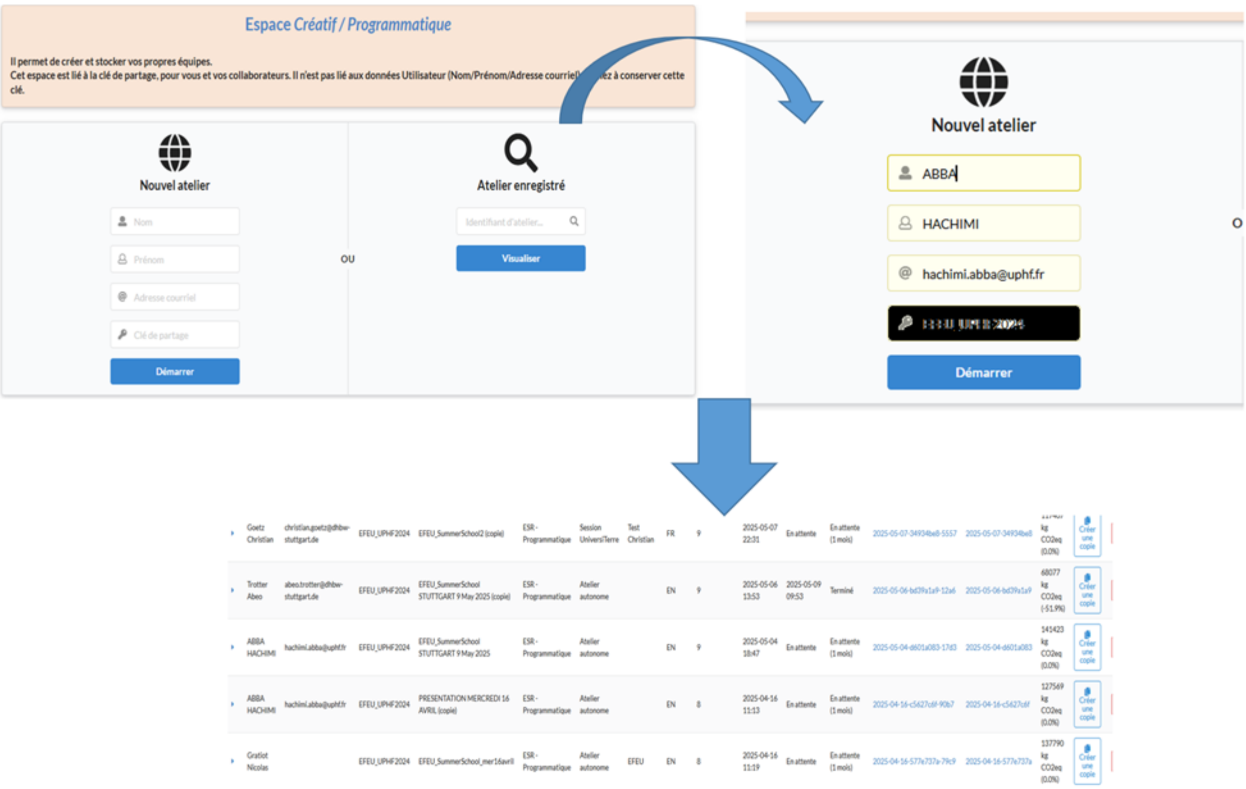

Figure 11: The EFEU Workspace in “Ma Terre”

Co-Creation of Characters and Scenarios for EFEU:

The adopted strategy focused on the co-creation of characters and scenarios. Each partner institution (DHBW, IPL, Metropolia, and UPHF) was assigned responsibility for defining characters relevant to their respective target audiences, including students and staff. The design of these characters was guided by key dimensions such as mobility habits, housing, food consumption, and purchasing behavior.

As a result of this collaborative process, an EFEU Character Profile Book was drafted, serving as a reference document for the implementation phase of the adapted game. (Figure 12 and Figure 13)

EFEU

EMISSION FREE EUROPEAN UNIVERSITIES
Strategic Development of Students' Sustainability Competencies:
Best Practices in Module Adoption, Transfer and Co-creation

Work Package #5
Student and Staff involvement – taking students and staff to universities´ emission neutrality
EFEU Serious Game Book of Characters

DHBW · Metropolia · Université Polytechnique Hauts-de-France · Politécnico de Leiria

Project n° 2022-1-DE01-KA220-HED-000085955

3 Characters

The following section presents the personas developed for the EFEU Serious Game, representing the diversity of lifestyles, motivations, and sustainability attitudes found in the European higher education context. Each character enables players to explore realistic sustainability dilemmas and supports experiential learning aligned with the objectives of Work Package 5 – Student and Staff Involvement.

Felix (Germany)

Role: Undergraduate Student, Electrical Engineering – DHBW Stuttgart, Germany

Attribute	Description
Profile Summary	19-year-old student living in a suburban area near Stuttgart. Commutes 30 minutes by train daily and lives with his parents. Plays football twice a week and travels to matches by car. Represents the balance between convenience, leisure, and emerging sustainability awareness.
Motivations & Goals	Efficiency and social interaction. Curious about technology but not yet proactive on sustainability. Seeks practical ways to save time and energy.
Behavioral Traits	**Food:** Omnivorous diet. **Mobility:** Train for commuting; car for leisure. **Leisure:** Football, streaming, digital gaming. **Decision Style:** Pragmatic and time-oriented.
Sustainability Challenge / Dilemma	High reliance on car transport for sports versus awareness of emission reduction.
Learning Relevance	Highlights the need to consider low-carbon transport in daily life decisions. Demonstrates how small shifts in habits can have cumulative environmental effects.
Annual CO_2 Emissions	10.7 t CO_2eq
Carbon Footprint Link (ADEME)	https://nosgestesclimat.fr/partage?total=10690

7

Figure 12: EFEU Serious Game – Book of Characters

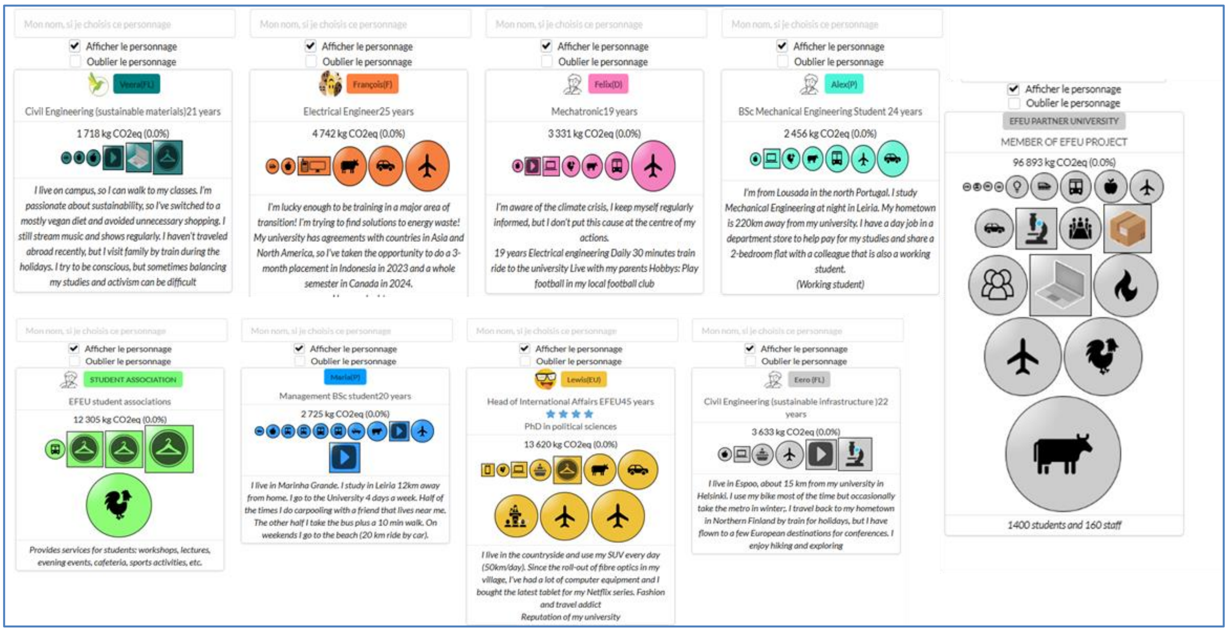

Figure 13: EFEU Serious Game - Scenarios

<u>Training of Facilitators:</u>

In order to qualify as facilitators for the serious game *"Ma Terre", a two-step training process () was completed:

- Participation in a *"Ma Terre"* workshop conducted by UPHF.
- Participation in a training session delivered by the game's creators at the University of Grenoble Alpes.

This structured approach ensured that facilitators acquired both practical experience through peer-led workshops and in-depth methodological knowledge directly from the original developers, thereby guaranteeing high-quality implementation within the EFEU project.

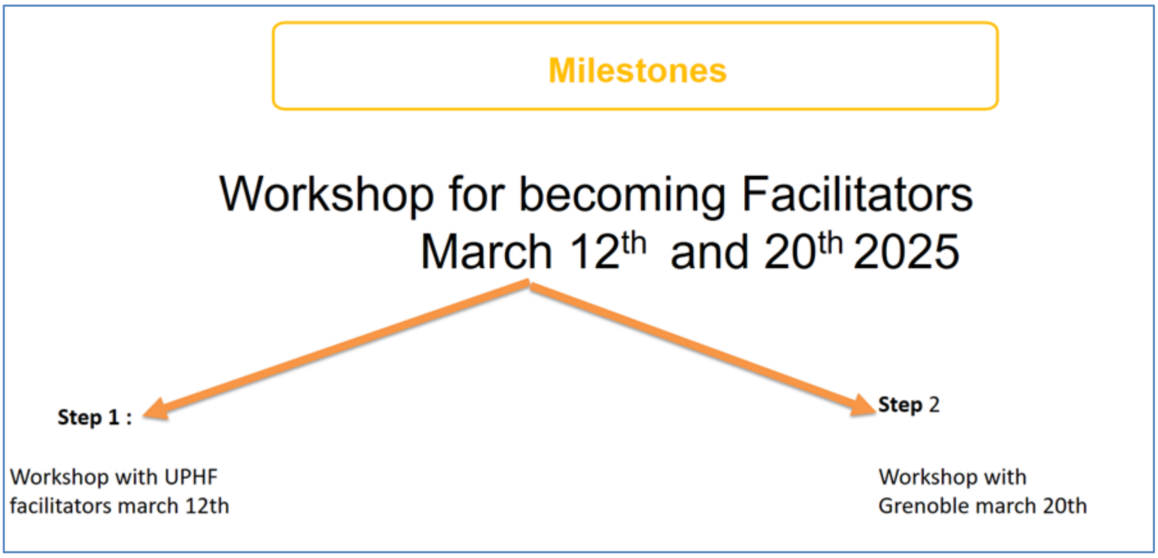

Figure 14: EFEU Serious Game – Facilitator Workshops

During the script development phase, the consortium sought the expertise of colleagues from Grenoble - specifically Nicolas Gratiot and the Ma Terre development team - who were invited to provide training for the participants (Figure 15). This training focused on facilitation and animation techniques to be applied during the upcoming EFEU Summer School 2025 in Stuttgart, Germany.

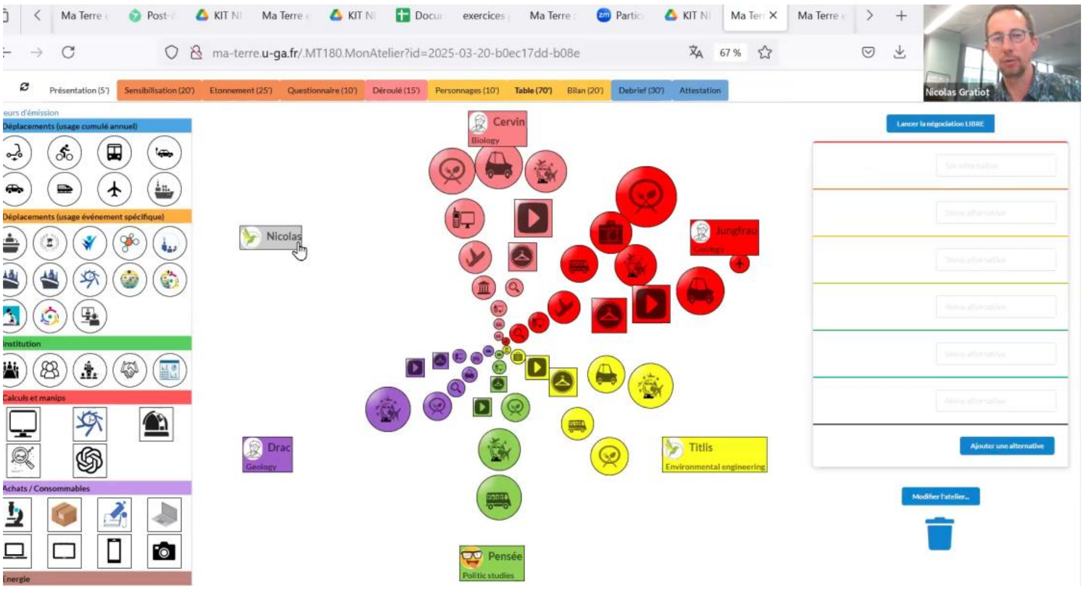

Figure 15: Training Session with University Grenoble Alps

4.4 Pilot Implementation of the EFEU Serious Game

The scenarios and characters co-created by the partners were consolidated into a unified game table. This version of the EFEU Serious Game was piloted on 9 May at DHBW Stuttgart, with students representing the four partner countries actively participating.

The figure below (Figure 16) illustrates the main game table developed for the EFEU serious game and used during the Summer School.

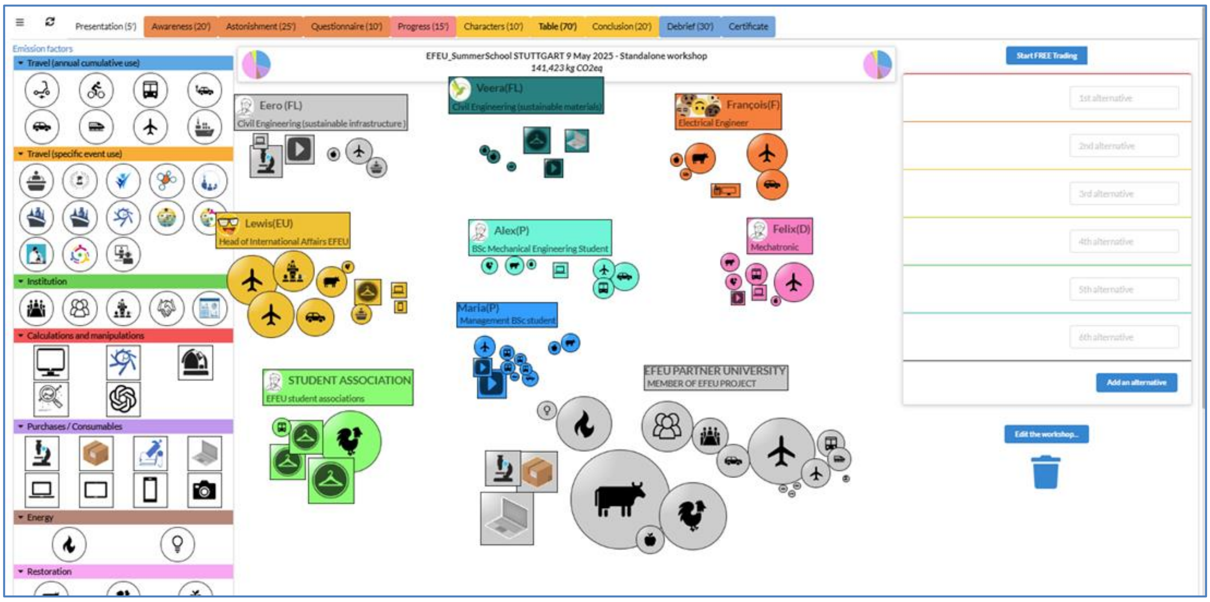

Figure 16: EFEU Serious Game – Implementation

During the Summer School, four game tables were conducted simultaneously, each addressing the challenge of reducing the total carbon footprint of the co-created characters by 50%. Every table was facilitated by an EFEU trainer who had previously received methodological training from colleagues in Grenoble (Figure 17).

The gameplay was structured into two phases:

- Individual Phase (Open Negotiation): Each character was invited to independently reduce their carbon budget.
- Collective Phase (Guided Negotiation): Participants engaged in a structured group negotiation to identify and agree upon collective strategies for further reduction.

Figure 17: Implementation the serious game during EFEU's Summer School 2025

The outcomes of the Summer School sessions were evaluated using three main criteria:

- Overall percentage reduction in CO_2 emissions, illustrated through diagrams to provide a clear visual representation of the achieved impact (Figure 18 and Figure 19).
- Comparative performance across the four tables, highlighting differences in strategy, negotiation, and effectiveness (Figure 20).
- Progress achieved at each negotiation step, allowing the monitoring of both individual and collective contributions throughout the game process (Figure 21).

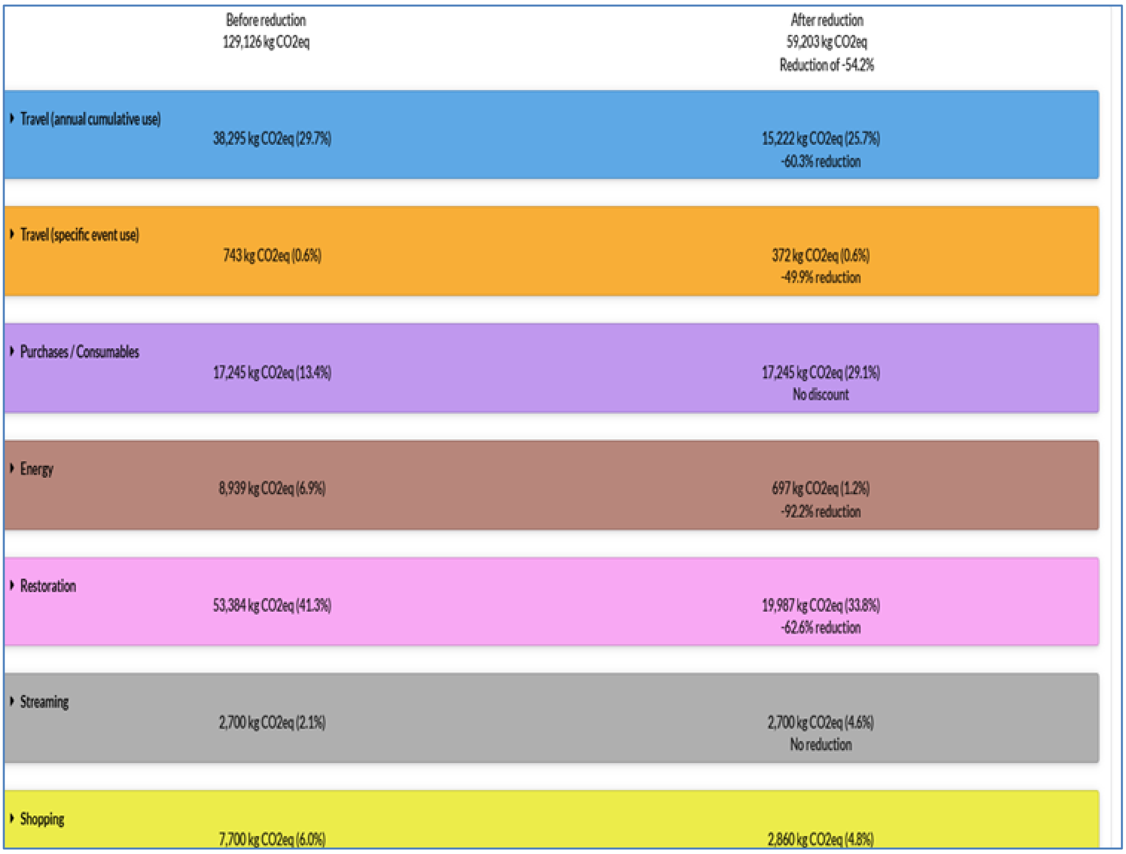

Figure 18: Game Outcome: Overall reduction in CO_2 emissions

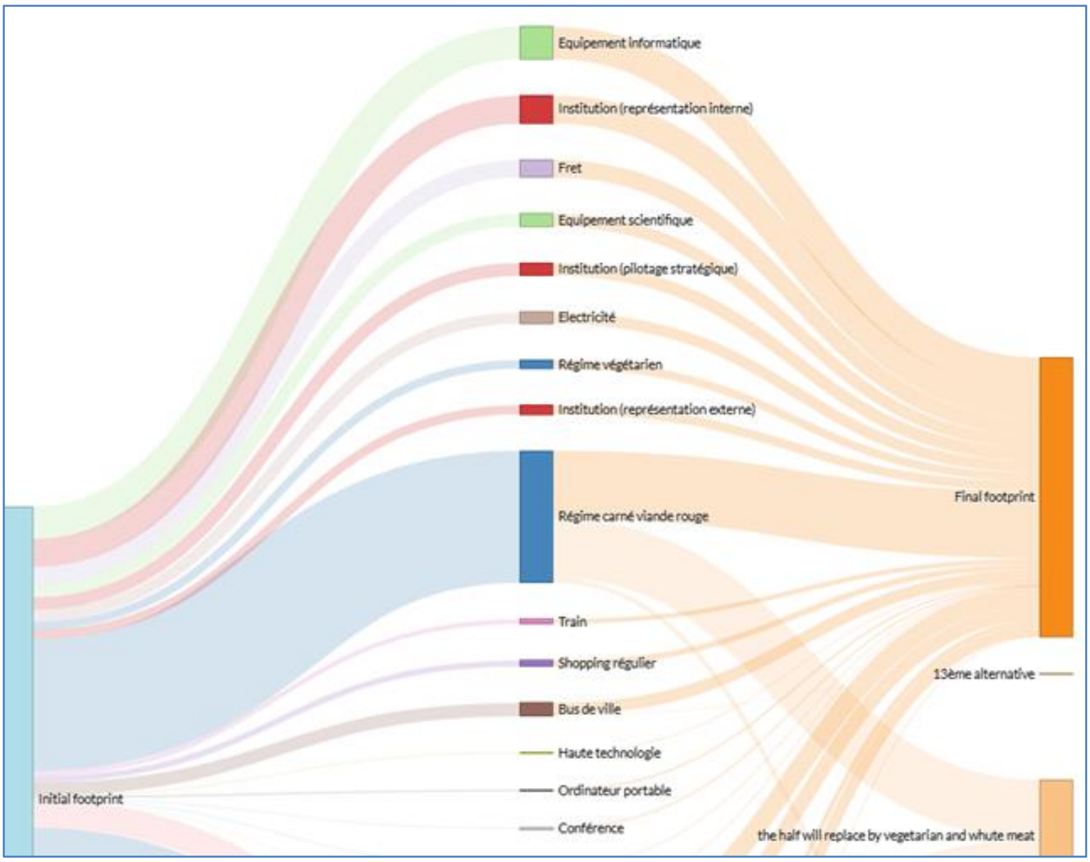

Figure 19: Game Outcome: Reduction in CO_2 emissions per emission factor

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Restauration								
Régime carné viande rouge	-30 056 -93.2%	32 234	-1 016	31 218 -3.2%	0	31 218 0.0%	-29 040	2 178 -93.2%
Régime carné viande blanche	-17 808 -93.7%	19 009	126	19 135 +0.7%	0	19 135 0.0%	-17 934	1 201 -93.7%
Régime végétarien	13 338 +622.7%	2 142	18	2 160 +0.8%	0	2 160 0.0%	13 320	15 480 +622.7%
Streaming								
Streaming 8h	-1 100 -55.0%	2 000	-1 100	900 -55.0%	0	900 0.0%	0	900 -55.0%
Streaming 3h	0 0.0%	600	0	600 0.0%	0	600 0.0%	0	600 0.0%
Streaming 1h	0 0.0%	100	0	100 0.0%	0	100 0.0%	0	100 0.0%
Shopping								
Shopping peu fréquent	-3 000 -65.2%	4 600	0	4 600 0.0%	0	4 600 0.0%	-3 000	1 600 -65.2%
Shopping addict	0 0.0%	1 600	0	1 600 0.0%	0	1 600 0.0%	0	1 600 0.0%
Shopping régulier	1 000 +66.7%	1 500	0	1 500 0.0%	0	1 500 0.0%	1 000	2 500 +66.7%
Equipement technologique								
Haute technologie	0 0.0%	120	0	120 0.0%	0	120 0.0%	0	120 0.0%
Bilan								
	-51 807 -36.6%	141 426	-4 979	136 447 -3.5%	0	136 447 0.0%	-46 828	89 619 -36.6%

Figure 20: Comparative performance across the four tables

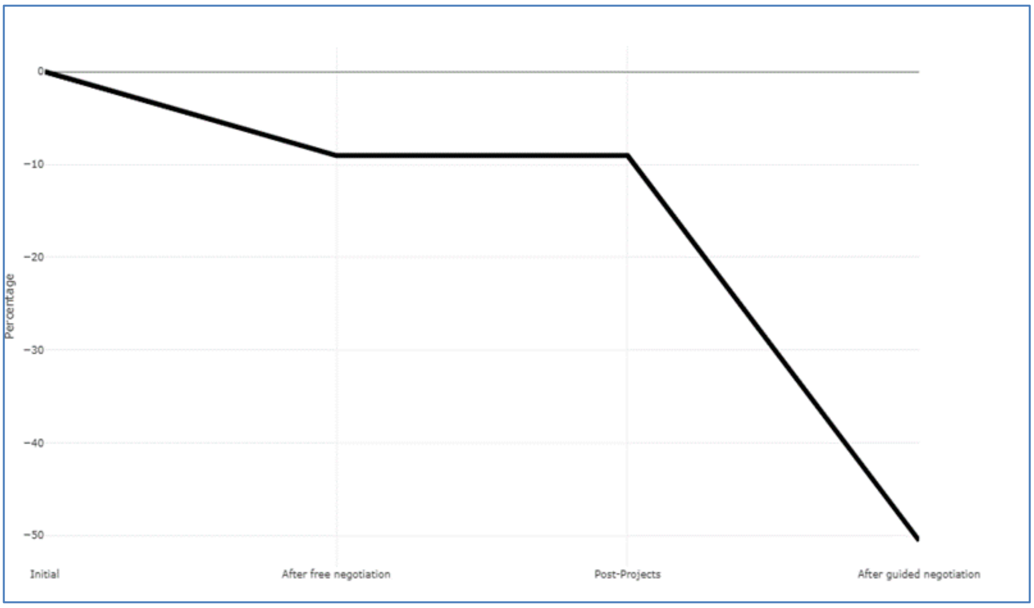

Figure 21: Achieved progress in negotiations

4.5 Impact on Stakeholders

The impact of the project on stakeholders is multi-dimensional and extends across institutional, pedagogical, and networking levels:

- **Capacity Building:** Each partner university has trained one or two facilitators for the serious game, thereby ensuring the capability for further dissemination and institutional integration.
- **Awareness Raising:** The game fosters increased awareness among students and staff regarding the carbon footprint associated with mobility practices.
- **Methodological Advancement:** The adapted *EFEU Serious Game* goes beyond the established *Climate Fresk* methodology, which has already been adopted by all four partner institutions, by combining awareness with actionable strategies.
- **Digital Accessibility:** The game, under the name *Erasmus+ EFEU*, is now available online and can be accessed globally within the framework of *“My Earth in 180 Minutes”*.
- **Network Building:** The initiative strengthens collaborative networks, particularly through partnerships with the University of Grenoble Alpes and the original *Ma Terre* development team, who have expressed openness to further cooperation.
- **Dissemination via Alliances:** Each university leverages its respective European alliance to disseminate the outcomes more broadly (e.g., EUNICE for UPHF, EU4DUAL for DHBW, U!REKA for Metropolia and RUN_EU for IPL)).

4.6 Conclusion and Next Steps

4.6.1 Conclusion and Forward Look

“Role-play simulation (RPS) exercises, and serious games in general, can be powerful educational tools in a wide range of situations, from the classroom to the high-stakes negotiating table” (Susskind et al., 2014). Online role-playing games, in particular, offer a strong potential to raise awareness and develop competences among young students. This demographic represents a substantial share of the 83.6% of internet users aged 16 to 64 who engage in video games (Digital Report 2022). In addition, statistics from the European Commission’s DESI (Digital Economy and Society Index) indicate that online services occupy an increasingly significant role across all domains.

Within this context, the *Erasmus+ EFEU Game Table* represents an important first prototype. While the pilot has successfully demonstrated the game’s potential, further improvement and contextual adaptation by each partner institution will be required in order to ensure long-term relevance and sustainability.

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4.6.2 Takeaways and Recommendations for Future Implementation

The development of a serious game entails a combination of complementary competencies within the project team, including:

- Information technology (IT) expertise,
- Scriptwriting and scenario design,
- Benchmarking of existing products and methodologies,
- Proficiency in a common working language across an international consortium.
-

Feedback gathered from the initial implementation phase underlines both the educational value of the tool and the need for iterative refinement. Key insights include:

- *“Very informative – the information guide provided key findings on climate change.”*
- *“Interesting to witness the impact of individual and group actions.”*
- *“The experience demonstrates that, in reality, achieving a 50% reduction is highly challenging.”*
- *“Certain aspects of the interface should be fine-tuned to enhance user-friendliness.”*

These findings provide a valuable foundation for the next project phase, during which the EFEU serious game will be optimized, adapted to diverse institutional contexts, and scaled for broader dissemination.

Drawing on the experience gained from developing and implementing a serious game within the EFEU project, the following recommendations are proposed to support future initiatives. These insights aim to guide educators, developers, and institutional partners in designing effective, engaging, and scalable serious games. The main advises are:

- Start from an existing game and adapt it, rather than building one from scratch.
- Create original, relatable characters with details such as country, academic role, name, and age to help players identify with them.
- Develop a clear, step-by-step scenario to be shared with future game session organizers.
- Enable benchmarking of game sessions to identify the most promising decarbonization strategies

4.7 Reflection and Achieved Results

The development and pilot implementation of the EFEU Serious Game marks a significant milestone in the Erasmus+ Emission Free European Universities (EFEU) project, demonstrating the power of role-play simulation (RPS) as an educational and engagement tool for climate action. Built on the adaptation of the French-developed Ma Terre en 180 Minutes game, the EFEU version was co-created by the four partner universities (DHBW, IPL, Metropolia, and UPHF) in close collaboration with the University of Grenoble Alpes and the game's original creators. This adaptation retained the original's focus on action-oriented decision-making while tailoring characters, scenarios, and themes to the higher education context.

The process combined benchmarking of climate-related serious games, creative adaptation of an existing concept, and structured collaboration among partners. Monthly coordination meetings ensured steady progress, while facilitator training—both from UPHF and the original game creators—enabled each partner to develop in-house expertise for ongoing use and dissemination. A shared digital workspace allowed for collaborative scenario design, character creation, and refinement of gameplay mechanics.

The first implementation at the EFEU Summer School in May 2025 demonstrated the game's potential for both engagement and education. Participants, representing the partner universities, worked in teams to reduce the fictional characters' carbon footprints by 50% through individual actions and collective negotiation. The structure of the game—beginning with individual reflection and transitioning to guided group problem-solving—provided an effective platform for illustrating the complexity of achieving ambitious climate targets. The results, recorded in tables and diagrams, underscored that while significant reductions are possible, reaching the 50% goal is challenging, reflecting real-world constraints.

The integration of the EFEU Serious Game into the role-playing environment of Ma Terre is a particular success. The EFEU Serious Game is accessible through the Ma Terre platform (Figure 22).
(Ma Terre en 180 http://ma-terre.u-ga.fr/.MT180.MonAtelier?id=2025-06-24-70106670-1697minutes)

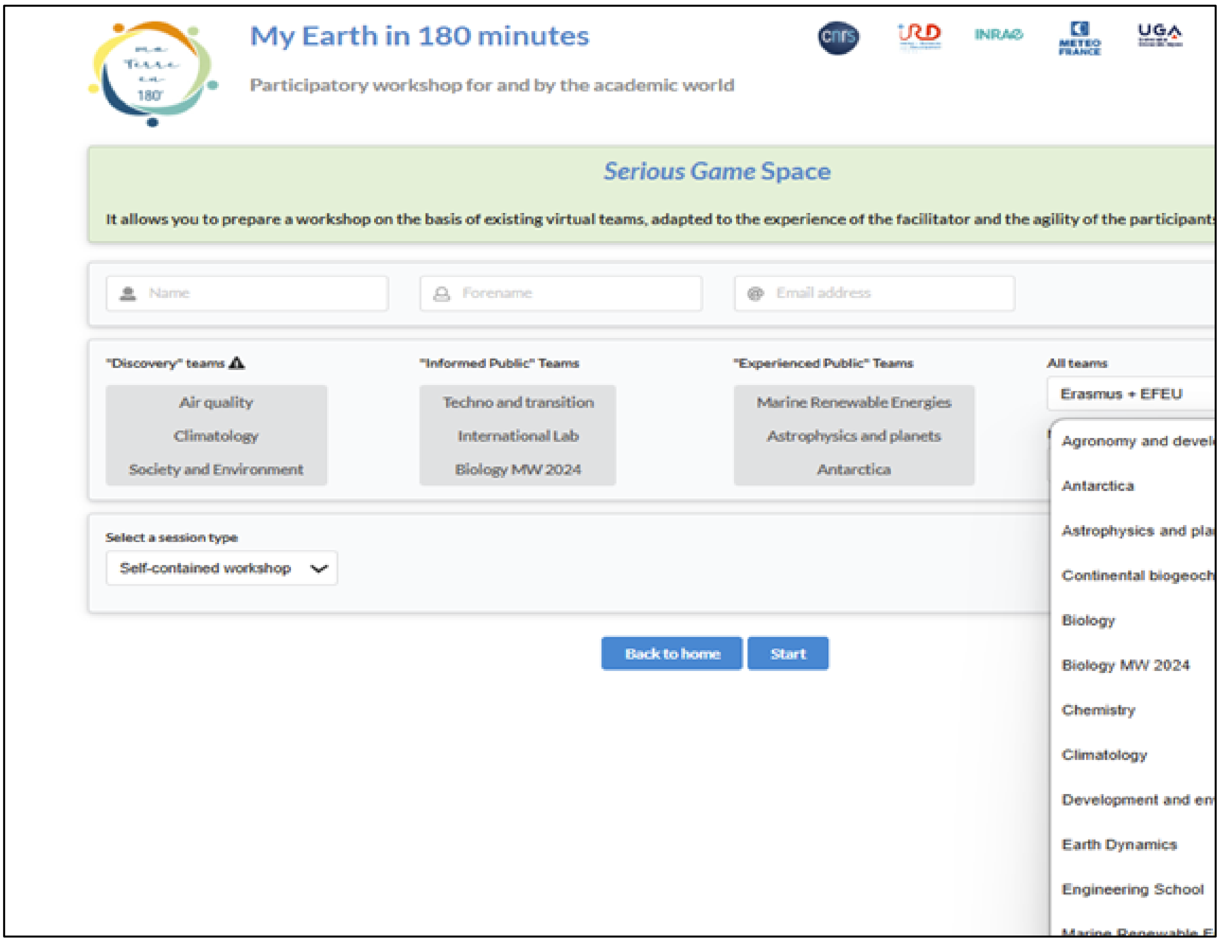

Figure 22: EFEU Serious Game embedded in the Ma Terre role-playing environment

Stakeholder impact has been multi-dimensional. All partner universities now have trained facilitators, ensuring long-term capacity for game-based sustainability education. Awareness of carbon-intensive behaviors—particularly in mobility—has increased among participants, and the game has already been disseminated beyond the immediate project network through alliances like EUNICE and EU4DUAL. Moreover, its availability in an online format opens opportunities for remote engagement, making the tool accessible from anywhere.
However, the pilot also revealed areas for improvement. User feedback highlighted the need for a more intuitive interface, minor refinements in the rules, and clearer guidance materials. Additionally, while the current version focuses on higher education contexts, partners see opportunities to adapt it for other audiences, including high schools and community groups.

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Looking ahead, the EFEU Serious Game should be seen as both a proof of concept and a living tool. Its co-creation process has strengthened inter-institutional collaboration, its initial use has validated its educational value, and its online adaptability offers vast dissemination potential. The next steps include:

- Refining the interface and user experience based on feedback.
- Expanding scenario diversity to reflect different institutional and cultural contexts.
- Embedding the game into broader sustainability curricula and workshops.
- Establishing a community of practice among facilitators to share experiences and best practices.

In essence, the EFEU Serious Game demonstrates that playful, immersive approaches can address serious topics like decarbonization in ways that are engaging, collaborative, and impactful. By combining informed decision-making, negotiation skills, and scenario-based learning, the game bridges the gap between abstract climate goals and the tangible actions needed to achieve them. Its continued development and dissemination will not only enhance the EFEU project's legacy but also contribute to a growing global movement using serious games as catalysts for sustainability transformation.

5 Activity 5.3 - Conducting Summer School

As part of Work Package 5, *“Student and Staff Involvement – Taking Students and Staff to Universities’ Emission Neutrality,”* the DHBW and UPHF teams were responsible for organising the EFEU Summer School 2025. This report documents the planning, implementation, and evaluation of this key project deliverable.

5.1 Overview of EFEU Summer School 2025

The EFEU Summer School 2025 was conceived as an innovative educational program under the umbrella of the Emission Free European Universities project. The primary aim of the Summer School is to provide students from the engineering sciences with practical and interdisciplinary sustainability skills. Students are provided with the opportunity to experience new and engaging teaching formats that convey knowledge, methods and tools for sustainable engineering in an intensive and collaborative learning environment.

The central objectives of the EFEU Summer School are:

- To developing sustainability skills: Students learn to integrate ecological, social and economic sustainability aspects into technical decision-making processes.
- To apply new learning formats: The Summer School pilots interactive, problem- and project-based learning methods that promote independent thinking and creative problem solving.
- To facilitate interdisciplinary collaboration: Participants work together in teams with different professional backgrounds to analyse systemic challenges and develop sustainable solutions.
- To advance practical learning: Through case studies, simulations and real project tasks, students acquire practical skills and learn how sustainability principles can be implemented in technical professions.
- To develop reflection and action competence: The Summer School supports students in reflecting on their experiences and determine their role as engineers in sustainable transformation and in identifying concrete possibilities for action in their future careers.

5.2 EFEU Summer School Development & Milestones

Development of the Concept (2021-2022):

The concept was conceived during the initial stages of the project's development. The idea was to provide an opportunity for university students of each project partner for cross-cultural exchanges, advancing sustainability competencies and awareness, and piloting developed project deliverables.

Ideation Phase: The concept was further developed during the fourth transnational project meeting (Figure 23) during which initial ideas (with suggested deadlines for implementation) were discussed with project partners. These ideas focused on:

- Developing a team dedicated to the development of the summer school (October 24th, 2024)
- Identifying the target audience, and the possibility of funding for potential participants (next project meeting)
- Making promotional material. Proposed ideas were a common video, flyer, and the EFEU Website (December 1st, 2024)
- Finalising lecturers, speakers, and activities (lecturers, site visits, topics of student projects – February 1st, 2025)
- Identifying supporting stakeholders e.g. DHBW's international office, etc.
- Identifying accommodation and commuting options and booking lecture halls (February 1st, 2025)
- Initiating the recruitment of students (February 1st, 2025)
- Finalising the schedule (April 1st, 2025)
- Submission of development report (May 31st, 2025)

Figure 23: 4th Transnational Project Meeting – co-creating EFEU Summer School

Planning:

- Dedicated team finalised plans regarding the schedule, and decided on the profile of speakers and facilitators and suitable strategies for advertising the event – February 2025
- Save-the-Date flyer (Figure 24) sent to project partners for distribution within their respective campuses and uploaded to the project website – February 2025
- Team reached out to relevant speakers and facilitators to present the objectives of the EFEU Summer School and expectations in the implementation of learning activities - December 2004 – April 2025
- Finalised the organisation of side events: Site visit to the Mercedes-Benz Museum – March 2025
- Worked alongside Mrs. Jeannine Schwarzkopf (a sustainability expert and agile coach, from the company, Impact Schmiede) and Mr. Mües (a consultant and sustainability expert with EPEA, a subsidiary of Drees & Sommer) to develop the student challenges, February – April 2025
- Conducted training and development sessions for the EFEU Serious Game with the developers of Ma Terre en 180 Minutes and trained facilitator, Dr. Hachimi Abba – March - April 2025
- Selected team-building activities – April 2025
- Designed a student assignment in the form of a reflective journal (see Annex 2 for the description of this assignment). Students were tasked to document their expectations, hopes, and concerns prior to the event and submit their entries to university representatives. Following the program's conclusion, they were expected to complete a follow-up reflection analysing their overall learning experience – April 2025
- Prepared schedule and information guide draft sent to the rest of the EFEU project team – March 2025
- Finalised schedule and information guide (Figure 25 and Figure 26), which were sent to the entire project team, participants, speakers, and facilitators, along with a welcome email – April 2025
- Developed feedback survey to gather insights from participants on their experience – April 2025
- Created certificate of completion (Figure 27) detailing the type of sustainability topics and competencies that would be addressed – April 2025
- Implemented the Padlet platform – April 2025 (Figure 28). This was a significant supporting tool created by EFEU project member, Dr. Klaus Homann. It is an open-

source space dedicated to providing announcements, instructions, and resources, and was therefore used to provide the information guide, uploading of relevant literature, the description of the student assignment (that is, the reflective journal) and challenges, planned activities and presentations, as well as introductory notes by participants, lecturers, and facilitators

- Attendance and Consent Sheets were created to confirm participation and confirm consent to be featured on the project's social platform and website – May 2025.

Figure 24: EFEU Summer School 2025 – Save the Date Flyer

DHBW Baden-Wuerttemberg Cooperative State University Stuttgart

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EFEU

EFEU Summer School 2025

FUTURE SKILLS FOR A SUSTAINABLE INDUSTRY

Guide and Information

Date:
May 5th - 9th 2025

Location:
DHBW Stuttgart
Lerchenstraße 1
70174 Stuttgart, Germany

Metropolia
Université Polytechnique Hauts-de-France
Politécnico de Leiria

Figure 25: EFEU Summe School 2025 - Guide

EPEA PART OF DREES & SOMMER

EFEU SUMMER SCHOOL 2025: Future Skills for a Sustainable Industry

EFEU

Monday May 5 Climate Change	**Tuesday** May 6 Sustainable Competencies	**Wednesday** May 7 Sustainable Competencies	**Thursday** May 8 Sustainable Design & Engineering	**Friday** May 9 Wrap Up
9:00 – 12:15 EFEU Summer School Opening • Meet & Greet • Welcome (Dean/Vice President of University) • Kick Off/Introduction to EFEU Summer School • EFEU SAX before • Masterclass #1 Life Cycle Assessment, S. Rossi	9:00 – 12:15 Workshop/Seminar: Future Skills for a Sustainable Industry – A Design Sprint Jeannine Schwarzkopf, IMPACT SCHMIEDE	9:00 – 12:15 Future Skills for a Sustainable Industry – A Design Sprint Presentation: Stuttgart Impact Hub Jeannine Schwarzkopf, IMPACT SCHMIEDE	9:00 – 12:15 • Sustainable Design & Cradle to Cradle principles • European Regulations: Ecodesign for Sustainable Products Regulation ESPR Jakub Mües et. al. EPEA	9:00 – 14:00 • EFEU Serious Game Hachimi Abba & friends • EFEU Summer School Wrap Up (CFC of EFEU Summer School, EFEU SAX after, group reflection, evaluation summer school)
Lunch Break				
13:30 – 16:45 Key Note #1: Climate Change & Human Health, Prof. Dr. med. M. Ebinger Keynote #2 Sustainable production materials, Prof. Dr.-Ing. J. Hirschmann Site Visit #1 Faculty Building School of Engineering & Laboratories	13:15 – 16:30 Workshop/Seminar: Design Thinking in Sustainable Engineering & in Circular Economy Jeannine Schwarzkopf, IMPACT SCHMIEDE	14:00 Site Visit #2 Mercedes Benz Museum 18:00 Evening Event: Stuttgart Spring Festival	13:15 – 16:30 EPEA Workshop Sustainable Design Jakub Mües et. al. EPEA	

Figure 26: EFEU Summer School 2025 – Schedule

CERTIFICATE OF ATTENDANCE

EFEU SUMMER SCHOOL 2025

Duale Hochschule Baden-Württemberg – Stuttgart - 5th to 9th May 2025

This is to certify that the above-mentioned individual has participated in the EFEU Summer School 2025. This individual has successfully demonstrated the ability to effectively work on sustainability-related challenges relating to climate change and eco-design strategies, contributing to the development of key sustainability competencies, including systems, futures, values, and strategic thinking, interpersonal skills, and integrated problem-solving.

Stuttgart, 9th May 2025

Prof. Dr. Klaus Homann — DHBW Duale Hochschule Baden-Württemberg Stuttgart

Prof. Jorma Säteri — Metropolia University of Applied Sciences

Dr. Judite Vieira — Politécnico de Leiria

Dr. Hachimi Abba — Université Polytechnique Hauts-de-France

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Figure 27: EFEU Summer School 2025 – Certificate of Attendance

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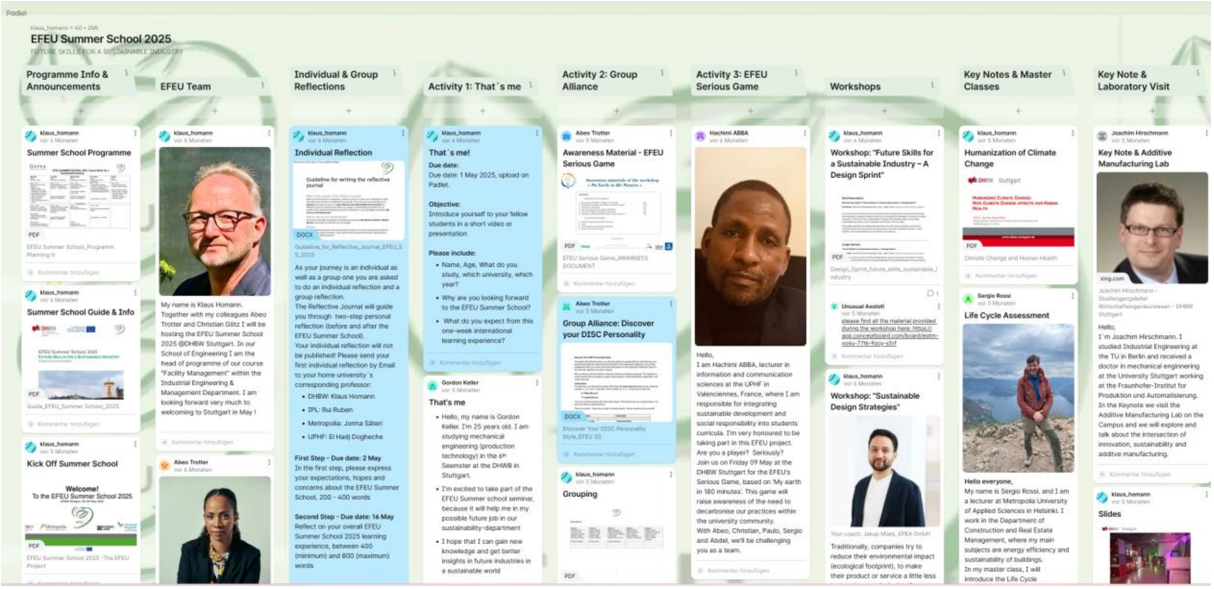

Figure 28: The EFEU Summer School 2025 Padlet-Platform

5.3 EFEU Summer School Implementation

The Summer School was delivered over five intensive days (May 5 – 9, 2025) at the DHBW-Stuttgart in Stuttgart, Germany. The first day began with a short meet and greet. The EFEU project team gave a welcome address and provided an introduction to the EFEU Summer School. Prof. Sergio Rossi gave a master class on Life Cycle Analysis (LCA) and provided the opportunity for students to consider the LCA on plastic water bottles.

Following this master class, Prof. Dr. med. M. Ebinger gave a presentation on Humanizing Climate Change: How Climate Change Affects Our Human Health, demonstrating the impact of high temperatures on the natural environment, human health and well-being, transmission risk of dengue, and public spending on health. The last presentation on the first day was done by Prof. Hirschmann, who presented on Sustainable Production Materials, by considering additive manufacturing, the megatrends and relevance of this process, field of application, and new thinking on construction. This presentation was followed by a site visit, a recognised active learning method, to the labs of the technical faculty at the DHBW-Stuttgart, allowing students to directly observe real-world environments, processes, and operations.

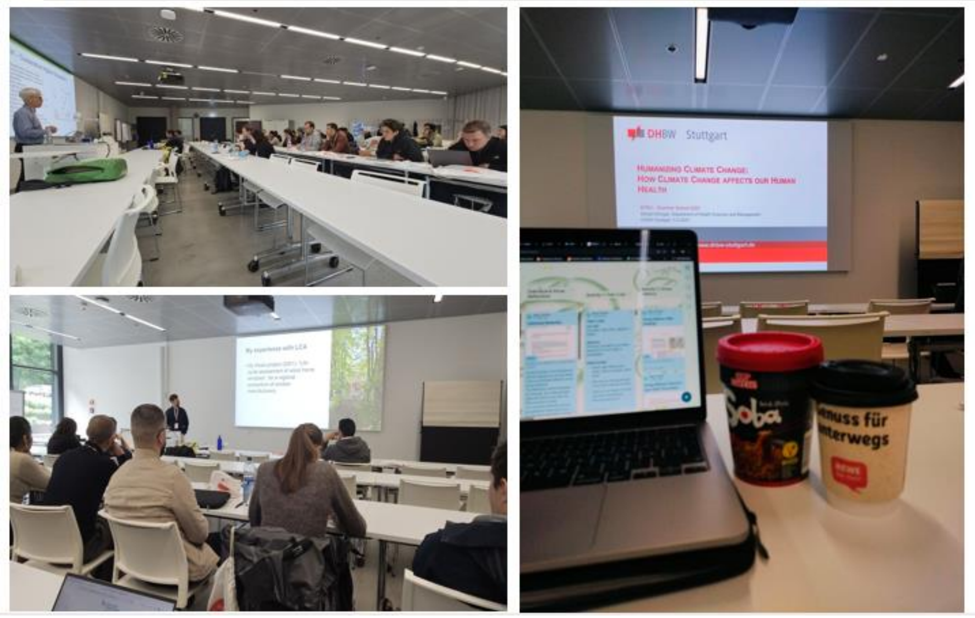

Figure 29: Day 1 of the EFEU Summer School 2025

Day 2 - 3

The student challenges commenced on the second day, under the theme: 'Design Thinking in Sustainable Engineering & in Circular Economy' and were facilitated by Mrs. Schwarzkopf. Students had the choice between two student challenges: One focused on nurturing sustainable mobility habits and the other featured proposals to advance sustainable infrastructure and teaching activities at university campuses. Over the course of two days, students worked in diverse teams and applied human-centred design principles to ideate, prototype, and test innovative solutions tailored to the university setting, resulting in a collection of practical, user-informed ideas ready to shape greener campuses.

The results featured compelling storytelling, striking 3D visuals, and strategic insights into sustainable mobility and infrastructure. These were evaluated by the EFEU Team, who provided feedback on the quality and effectiveness of solutions. The day ended with an inspiring debrief by the integration of visionary insights from industry and world leaders and inclusion of inspirational video presentations.

Figure 30: Day 2 – 3 of the EFEU Summer 2025

Day 4

With Mr. Jakup Mües at the helm, Day 4 focused on the Circular Economy—a key driver of sustainable industrial transformation. Students explored how smart design and digital innovation can lead to circular, compliant, and future-forward products. Alternative business models, regulatory frameworks, and emerging technologies were all on the table. The students presented their ideas to the EFEU team, who provided insights on the presented ideas.

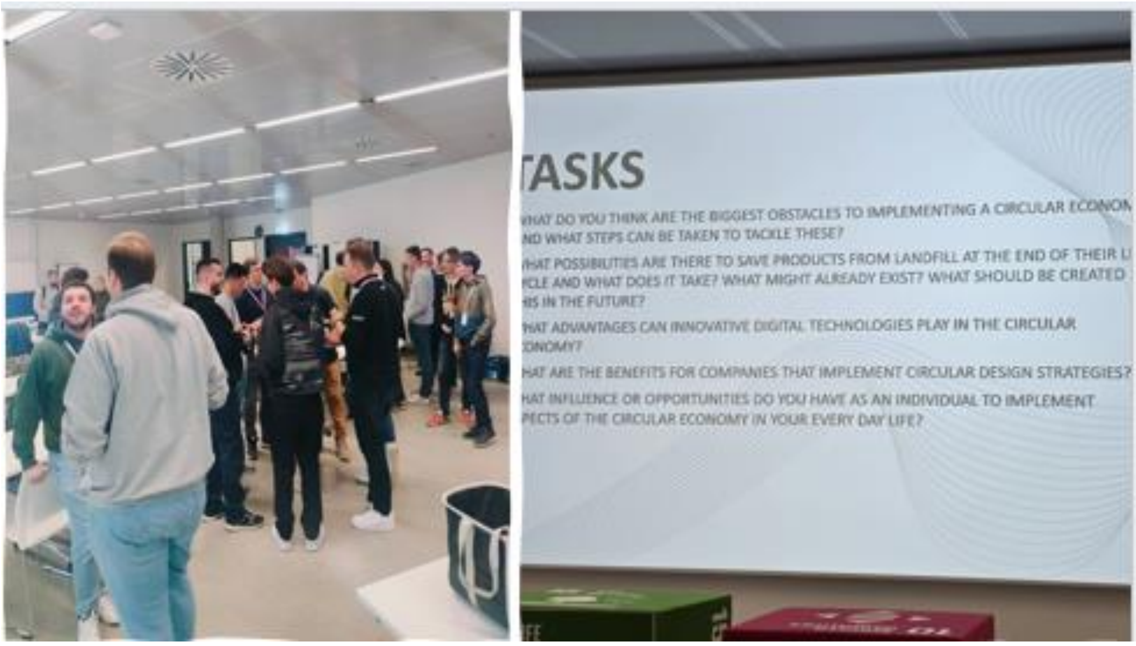

Figure 31: Day 4 - EFEU Summer School 2025

Day 5

The final day of the Summer School started off with the piloting of the EFEU Serious Game, inspired by Ma Terre en 180 Min—a thought-provoking simulation that challenged participants to reimagine climate action on personal, professional, and institutional levels. The game has been developed by researchers of the Grenoble University, but a separate interface was designed and implemented by EFEU project member, Dr. Hachimi Abba. The experience highlighted the urgency of climate action but also assessed the level of difficulty in making the necessary adjustments.

After some spirited feedback on the game, students turned their attention to reflecting on the overall experience at the Summer School. The day closed with testimonials and deep reflections from participants. Each student selected a Sustainable Development Goal (SDG) that personally resonated with them—a moment that underscored how the experience had impacted them. The handover of certificates of completion and a celebratory photo session brought the week to a close. Students also received a digital certificate through the open badge system.

Summary of the Event

A wrap-up video documenting the students' experiences is available through the project website: https://www.dhbw-stuttgart.de/forschung-transfer/technik/projekte/efeu/efeu-testimonials/ and via the DHBW-Stuttgart Youtube Channel: Summer School 2025 - Recap.

An overview is also available via the EFEU project's LinkedIn page: [Emission Free European Universities - EFEU: Posts | LinkedIn.]() A number of our participants and facilitators also used LinkedIn to provide reflections and insights on the experience.

Figure 32: Final Day of EFEU Summer School 2025

5.4 Partner Engagement

Academic institutions were represented by the four partner universities, namely DHBW-Stuttgart, Institute Polytechnic Leiria, Metropolia University of Applied Sciences, and University Polytechnic Hauts-de-France.

Several other external stakeholders were integrated into the implementation of the EFEU Summer School. One of which is the company IMPACT SCHMIEDE, represented by Jeannine Schwarzkopf. Mrs. Schwarzkopf is an expert in design thinking and agile methodologies in promoting sustainable design. Another represented stakeholder was EPEA GmbH, part of Drees and Sommer Group, a firm focused on the development of circular industrial products, buildings, and urban districts.

5.5 Dissemination and Recruitment Strategy

To recruit students and raise visibility, a multi-pronged dissemination campaign was launched:

Channels used:

- University Campuses: All partner institutions circulated the Summer School Save-the-Date Flyer via university mailing lists, digital dissemination platforms and within their respective classes.
- EFEU Project Website: The flyer and Information Guide were uploaded to the project website, which can be accessed via https://www.dhbw-stuttgart.de/efeu.

Participation Outcome: A total of 28 students officially registered and participated in the Summer School, comprising 7 students from the DHBW-Stuttgart, 7 students from Metropolia University of Applied Sciences, 8 students from the Polytechnic Institute of Leiria, 5 students from the University Polytechnic Hauts-de-France, and 1 external student from the University of Stuttgart.

5.6 Constraints and Hurdles

Several interrelated challenges were experienced during the development and implementation of the EFEU Summer School, particularly in the areas of partnership coordination and logistical execution. One of the primary difficulties was aligning expectations among project partners, as differing perspectives emerged regarding academic rigour and applied learning. After some negotiation, speakers and challenges were finalised based on a shared understanding of the school's objectives and ensuring the learning content of the planned learning activities was accessible to all students.

From a logistical standpoint, integrating the EFEU Serious Game into the students' workflow introduced technical and operational hurdles. To ensure smooth implementation, four project members underwent targeted training, and further IT support was necessary to support the game's implementation. Moreover, the organisation of the 5th Transnational Project Meeting (TPM), scheduled midweek, added to the planning complexity. Hosting the meeting on the third and fourth days of the week required significant coordination efforts to finalise arrangements, manage schedules, and ensure active participation from all partners.

5.7 EFEU Summer School 2025 Evaluation

A feedback survey was designed and developed in QuestionPro. The survey was distributed to students on the final day of implementation. The results of the survey indicated that 23 respondents completed the survey, the majority being third year students, making up 50% of the event's participants. Other major findings are summarised below.

I: Close-ended Questions

As illustrated in Table 1, the EFEU Summer School was a successful implementation with students providing largely positive reviews. High ratings were given on the overall experience,

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structure and organisation, the quality of facilitators, the level of engagement of learning activities, and the impact on their understanding of sustainability topics (80% of participants gave a rating of 4 or 5).

Questions with the lowest ratings (69% of participants with ratings of 4 or 5) were those related to the relevance of content to their interest or goals and the influence of the summer school on perceptions or personal actions regarding climate protection.

Questions	Responses (1: Poor – 5: Excellent)				
	1	2	3	4	5
1. How would you rate your experience?			12.5% (N=3)	33.3% (N=8)	54.2% (N=13)
2. How did you find the structure and organisation of the activities?			8.3% (N=2)	50% (N=12)	41.7% (N=10)
3. How would you rate the facilitators' delivery of content?		4.2% (N=1)	8.3% (N=2)	45.8% (N=11)	41.7% (N=10)
4. How would you rate the level of engagement of the learning activities?			4.2% (N=1)	29.2% (N=7)	66.7% (N=16)
5. How did you find the learning materials?		4.2% (N=1)	16.7% (N=4)	37.5% (N=9)	41.7% (N=10)
6. How relevant was the sustainability content to your interests or goals?		4.4% (N=1)	26.1% (N=6)	26.1% (N=6)	43.4% (N=10)
7. How would you rate the impact of the EFEU Summer School on your understanding of sustainability topics, e.g. climate protection?			8.7% (N=2)	47.8% (N=11)	43.5% (N=10)
8. How would you rate the development of skills related to climate protection on your future studies and professional careers?		4.4% (N=1)	17.4% (N=4)	56.5% (N=13)	21.7% (N=5)
9. How would you rate the influence of the summer school on your perceptions or personal actions regarding climate protection?			30.4% (N=7)	43.5% (N=10)	26.1% (N=6)

Table 2: Summary of Responses from EFEU Summer School Participants

II: Multiple-Response Question

In response to the question on the most impactful activity, over 60% of students indicated a strong preference for Workshops 1 and 2, indicating the value of challenge-based learning.

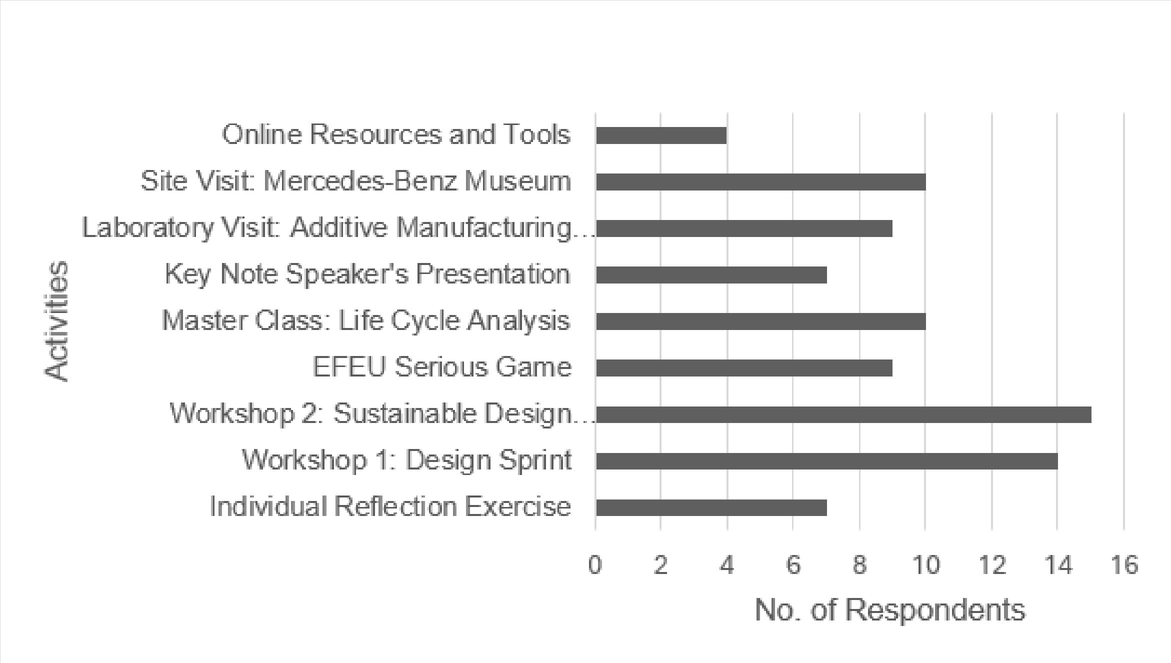

Table 3: Aspects of the EFEU Summer School that students found most impactful

III: Open-ended Questions

Responses to the posed open-ended questions are included below.

Q1: What would you improve in the structure, organisation, learning activities and materials, and delivery of the program?

- *It was a very good experience with good activities and people involved. I wouldn't change a thing!*
- *To further enhance the experience, ensuring a balanced time allocation for activities and discussions could improve interaction and participation.*
- *There should be a few (3 - 5) and short online classes about the theorie. Wirh this it would be more practical.*
- *I think in general it was really good. But I think there could be more content about automotive Industry. We are in Germany!!!*
- *May be a few more days to the school and some more industry experts that could share their success stories on how they achieved sustainable standards in their professional or personal journey.*

Q2: Were there any sustainability topics or competencies you believe should have been included or explored in greater depth?

- *Impact of the European automotive industry, not only on carbon emissions, but also on the impact of materials and their development*
- *No. It was very multidisciplinary summer school and I learned a lot!*
- *Carbon capture technology or alternatives*
- *More about scientific researches und results*

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5.8 Conclusions and Next Steps

The EFEU Summer School 2025 marked a significant milestone in the EFEU project. This project deliverable furthers one of the intended objectives of the EFEU project, increasing the sustainability competencies of engineering students. Despite the few encountered challenges, the program demonstrated the strength of cross-sector and cross-border collaboration, interdisciplinary learning, and the value of integrating traditional and innovation teaching approaches in addressing real-world sustainability challenges.

Participants engaged with tools such as life cycle analysis, design sprints, challenge-based learning, active learning, and a role-based serious game fostering the advancement of systems, futures, values, and strategic thinking, interpersonal skills and integrated problem solving.

The partners are exploring the possibility of continuing the EFEU Summer School to maintain its core mission of fostering interdisciplinary learning and collaborative partnerships among students, researchers, industrial partner, and professionals. It will also serve as a platform for furthering sustainability education and the testing of innovative teaching approaches and tools.

To ensure long-term impact, the following recommendations are proposed:

- Plan well in advance: Design future programs 8–10 months ahead to allow sufficient time for promotion, coordination, and participant recruitment.
- Extend program duration: Offer longer sessions to enable deeper engagement with content.
- Refine learning content: Where feasible, tailor content to maintain accessibility for students from diverse academic backgrounds while aligning more closely with their professional aspirations. These refinements should also encourage more substantial shifts in perception and personal action on climate protection.
- Ensure financial accessibility: Secure funding to support students who may face barriers covering travel and accommodation costs.

5.9 Achieved Results

The EFEU Summer School 2025 represented a landmark achievement within the framework of the Emission Free European Universities project, successfully translating the project's sustainability objectives into an immersive, interdisciplinary learning experience. Over five intensive days, the program brought together engineering students from four partner universities and one external institution, fostering cross-cultural exchange, collaborative problem-solving, and the development of competencies essential for driving sustainability in industry.

The Summer School's design combined academic rigor with innovative, practice-oriented teaching methods. Through master classes, interactive workshops, design sprints, challenge-based learning, site visits, and the piloting of the EFEU Serious Game, participants were exposed to a diverse range of sustainability tools and frameworks. This multifaceted approach enabled students to not only deepen their theoretical understanding of sustainability but also to apply their learning to real-world contexts, resulting in actionable, user-informed solutions for greener university campuses and industrial practices.

Feedback from participants confirmed the program's overall success. High ratings were given for the quality of facilitation, engagement in activities, and the contribution to participants' understanding of sustainability. Workshops and challenge-based activities were highlighted as the most impactful components, reinforcing the value of experiential and participatory learning formats. While some participants suggested greater alignment of topics with their professional interests—such as deeper exploration of automotive industry impacts or emerging technologies—the prevailing sentiment emphasized the program's multidisciplinary richness and the quality of peer collaboration.

The event also demonstrated the importance and feasibility of cross-sector collaboration. Contributions from industry partners such as IMPACT SCHMIEDE and EPEA GmbH enriched the program with professional insights, bridging the gap between academic knowledge and industrial application. This interplay between academic and industry perspectives underscored the program's central message: achieving sustainability in engineering requires integrated thinking, systemic approaches, and cooperation across disciplines and sectors.

Despite its success, the Summer School faced notable challenges. Coordinating among multiple partners with different expectations required careful negotiation to balance academic depth with practical accessibility. Logistical hurdles, including the integration of the EFEU Serious Game and the concurrent hosting of the 5th Transnational Project Meeting, tested the organizational capacity of the team. These challenges, however, were overcome through adaptability, effective communication, and proactive planning.

Looking forward, the Summer School offers a scalable and replicable model for sustainability education in higher education institutions. Key recommendations for future iterations include extending the program's duration to allow deeper exploration of content, refining thematic focus to align with diverse academic backgrounds and professional aspirations, and securing financial support to ensure broad accessibility. Furthermore, integrating follow-up mechanisms—such as continued collaboration among participants and tracking the long-term impact on their studies and careers—could strengthen the program's legacy and contribution to sustainability education.

In essence, the EFEU Summer School 2025 not only achieved its immediate objectives but also laid the groundwork for ongoing innovation in teaching sustainability. By combining academic expertise, industry insight, and student creativity, it created a vibrant platform for generating solutions to real-world challenges. The program demonstrated that when students are given the tools, environment, and collaborative networks to engage deeply with sustainability, they can produce ideas and approaches that are both visionary and pragmatic. The continued evolution of such initiatives will be critical for equipping the next generation of engineers and professionals to lead the transition toward a more sustainable, resilient, and equitable future.

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