Course guide
295920 - ASIE - Applied Sustainability in Engineering

Last modified: 02/10/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: SERGI VINARDELL CRUAÑAS

Others: Primer quadrimestre:
CESAR ALBERTO VALDERRAMA ANGEL - Grup: M1
SERGI VINARDELL CRUAÑAS - Grup: M1

TEACHING METHODOLOGY

The course will combine theoretical lectures with practical exercises to be completed individually, as well as specific case studies to be analysed and solved in groups. Specifically, the following activities will be carried out during the course:

1. Lectures, participative sessions and problem-solving sessions
2. Case studies
3. Project task
4. Final Exam

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student will be able to:

• Demonstrate a good knowledge and understanding of the tools used for sustainability analysis with emphasis on life cycle assessment, carbon footprint and life cycle costing.
• Evaluate the technological, environmental and economic feasibility of a system through the life cycle perspective.
• Identify sustainable energy technologies, efficient energy storage systems and critical raw materials needed for the energy transition.
• Distinguish between different waste-to-resource and waste-to-energy solutions to promote circular and sustainable waste management solutions.
• Apply low-carbon and defossilized technologies into industrial processes.

STUDY LOAD

Type	Hours	Percentage
Hours large group	36,0	24.00
Hours small group	24,0	16.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

General Framework

Description:
1. Definition and principles of sustainability. Key characteristics and evolution of climate concern and policy-related instruments. European Green Deal and primary EU climate policies. Environmental pressures and the IPAT equation. Description of sustainability solutions in line with EU climate policies.

Related activities:
Solving problems related to the topic content.
Project.

Full-or-part-time: 23h
Theory classes: 3h
Laboratory classes: 2h
Self study : 18h

Sustainability Assessment

Description:
2.1. Life cycle assessment (LCA):
Framework and applications. LCA stages. Goal and scope definition. Attributional and consequential LCA. Inventory analysis. Multifunctionality: allocation and system expansion. Impact assessment. LCA software and databases. Carbon footprint methodology.

2.2. Life cycle costing (LCC):
Key concepts. Time value and cost-benefit analysis. LCC methodology. Working flow for a LCC.

2.3. Social life cycle assessment (S-LCA):
General framework. S-LCA methodology. Stakeholder categories. Impact subcategories. Social life cycle impact assessment. PSILCA database.

Related activities:
Solving problems related to the topic content.
Case study 1.

Full-or-part-time: 46h
Theory classes: 10h
Laboratory classes: 10h
Self study : 26h

Sustainable Energy Systems

Description:
3.1. Renewable Energy Systems:
General context. Solar photovoltaic. Solar Thermal. Wind Power; onshore and offshore systems. Hydropower. Geothermal.

3.2. Energy Storage and Hydrogen:
Regulatory framework. Energy storage to accomplish national and EU renewable energy targets. Battery Energy Storage System and Li-ion batteries. Pumped Storage Hydropower. Power-to-X. Renewable hydrogen production. Hydrogen-to-X pathways.

3.3. Critical raw materials and their supply chain:
General EU context. Critical raw materials; characteristics and global supply. EU list of CRMs. Criticality assessment methodologies. CRMs for Li-ion batteries, solar photovoltaic, wind turbines. Supply chain resilience.

Related activities:
Solving problems related to the topic content.
Case study 2.

Full-or-part-time: 30h
Theory classes: 8h
Laboratory classes: 4h
Self study : 18h

Waste-to-Resource and Circular Economy

Description:
4.1. Introduction to circular economy:
Definition and principles. Key characteristics and enabling factors of a circular economy. Resource, environmental, economic and social benefits of circular economy. Circular economy in the European and global context. EU Circular Economy Action Plan.

4.2. Waste-to-Resources:
General context. Biowaste and biorefinery concepts. Urban mining. Characteristics of urban wastes and potential for resource recovery. Critical raw materials contained in urban wastes. Challenges of urban mining.

4.3. Waste-to-Energy:
Introduction to waste to energy (WtE) conversion. WtE conversion in the framework of Circular Economy Policy and EU perspective. WtE technology options. Thermal treatment of municipal solid waste (MSW) by pyrolysis and gasification. Waste-to-Bioenergy. Anaerobic digestion. Incineration of municipal solid waste. Environmental impacts of WtE conversion plants.

Related activities:
Solving problems related to the topic content.
Case study 3.

Full-or-part-time: 30h
Theory classes: 8h
Laboratory classes: 4h
Self study : 18h

Sustainable Industrial Processes

Description:
5. Introduction to industrial sustainability. Regulatory framework. European Union Emission Trading System (EU ETS). Enabling key factors to decarbonize industrial processes. Examples of industrial relevance.

Related activities:
Solving problems related to the topic content.

Full-or-part-time: 10h
Theory classes: 3h
Laboratory classes: 2h
Self study : 5h

Sustainability in a Global Scope and Perspective

Description:
6. General framework and mainstream economic thinking. Planetary boundaries. Economic growth and green growth. Decoupling growth and environmental impact. Introduction to heterodox and post-growth economic models.

Related activities:
Solving problems related to the topic content.

Full-or-part-time: 11h
Theory classes: 4h
Laboratory classes: 2h
Self study : 5h

GRADING SYSTEM

1. The evaluation will include three case studies and one project task. For each case study, students will be required to submit a written report. The project will be presented orally. All these activities will be completed in groups.
2. There will be a final exam designed to assess the learning objectives achieved by the student. It will consist of theoretical questions and problem-solving exercises.

The final grade will be calculated using the following formula:

Final grade = FEX*0.45+CS*0.35+PRO*0.20

FEX: Final Exam
CS: Case studies
PRO: Project

The course does not have revaluation exam.

BIBLIOGRAPHY

Basic:
- Reddy, Krishna R.; Cameselle, Claudio; Adams, Jeffrey A. Sustainable engineering : drivers, metrics, tools, and applications. Wiley, 2019. ISBN 9781119493938.
- Hunkeler, David; Lichtenvort, Kerstin ; Rebitzer, Gerard. Environmental life cycle costing [on line]. Pensacola, Fla: CRC Press, 2008 [Consultation: 11/07/2025]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=570462. ISBN 9780429140440.
- ISO 14040:2006. Environmental management - life cycle assessment - principles and framework. International Standards Organization, 2006.
- ISO 14044:2006. Environmental management - life cycle assessment - requirements and guidelines. International Standards Organization, 2006.
- Jackson, Tim. Prosperity without growth: economics for a finite planet. Routledge, 2009. ISBN 9781844078943.
- Klinghoffer, Naomi B.; Castaldi, Marco J. Waste to energy conversion technology [on line]. Oxford: Elsevier Science & Technology, 2013 [Consultation: 11/07/2025]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1574937. ISBN 9780857096364.
- Guidelines for social life cycle assessment of products and organisations [on line]. United Nations Environment Programme, 2020 [Consultation: 11/07/2025]. Available on: https://www.lifecycleinitiative.org/wp-content/uploads/2021/01/Guidelines-for-Social-Life-Cycle-Assessment-of-Products-and-Organizations-2020-22.1.21sml.pdf.
- Yang, Peter. Renewable energy : challenges and solutions [on line]. Cham: Springer International Publishing, 2024 [Consultation: 11/07/2025]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-031-49125-2. ISBN 9783031491252.

RESOURCES

Other resources:
Other resources will be provided by the professors during the development of the course through ATENEA platform.