UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Non-Renewable Resources – Global Abundances, Incidences, and Accessibility

2627-1-F7603Q005-F7603Q00501

Aims

The teaching of this module is aimed at providing the knowledge and the methodological basis to understand the principles concept related to the interface between resource, production and consumption systems and related environmental pressures and impacts.

Objectives
The course will focus on the key processes, practices and sectors relying on resources and how their pressure and impacts on environment could be systematically addressed by means of approaches assessing supply chains, like life cycle assessment. These approaches allow assessing the interplay between resources and impacts, modelling cause-effect chains, and comparing effects with the limits of the planet.
Hence, this course provides an in-depth examination of the challenges and opportunities associated with non-renewable resources, resource efficiency, circularity. Students will learn about the impacts of human activities on the environment, the importance of sustainable resource management, and the principles and practices of supply chain assessment. The course aims to equip students with the knowledge, skills, and tools to design and implement sustainable solutions that minimize environmental degradation and promote resource efficiency.
Students are invited to consult the syllabus of the entire course for details regarding learning and skill-related objectives.

Knowledge and Understanding (Dublin Descriptor 1)
At the end of the course, the student understands:

- Definition of abiotic resources and raw materials
- Understand the concept of non-renewable resources and their environmental impacts
- The responsible and sustainable use of non-renewable resources
- The Circular economy vs Spiral Economy
- Resource efficiency and circularity
- The concept of planetary boundaries in relation to abiotic and non-renewable sustainable resource management

- Life cycle assessment and beyond its limitations
- The importance of equilibrium, steady state and kinetics of processes related to use of non-renwable resources and sustainability
- The main EU and international policies linking resources, supply chains assessment, planetary boundaries and sustainability

Furthermore, students acquire, review, and strengthen their knowledge regarding:

- the interconnected environmental-ecnomical-social-ethical environment complexity
- how the non-renewable resource improper use influences the atmosphere, oceans, biology of living organisms and humans
- the non-renwable resources distributions between different environmental compartments
- the standards and procedures for predicting and assessing the various impacts of environmental pollution (in terms of use in Environmental Impact Assessments (EIA), Strategic Environmental Assessments (SEA), and Integrated Environmental Authorizations (IPA)), tools for managing public relations in preventive environmental assessments; key environmental law regulations (European and national)
- the economic impact of pollution related to the concept of (negative) externalities, public goods, and the monetary valuation of pollution
- the use of some multivariate analysis techniques in the service of decision-making
- the difference between equilibrium and steady state and their application domains in a sustainability perspective

Applied Knowledge and Understanding (Dublin Descriptor 2)
At the end of the course, the student will be able to:

- list the most important non-renewable materials and the emerging ones
- discuss about the sustainability of the non-renewable material use
- calculate the LCA of some non-renewable materials
- hypothesize the environmental and socio-economic estarnalities of a wrong use of non-renewable resources
- identify compounds with potential impact on other environmental compartments and on humans and ecosystems from a one health perspective, and identify strategies for mitagate their release
- know how to apply legal regulation to protect the environment (present and future), and foster critical thinking in identifying problems and developing related solutions
- know how to critically analyze the evolution of use of non-renewable resources in response to evolving energy and environmental policies at the national and supranational levels
- know how to assess the need for a multivariate approach to analyzing socio-economical-scientific data and evaluate the information that can be extracted from them
- evaluate the spatio-temporal evolution of non-renewable resources follwing concepts related to equilibrium and/or the stability of non-equilibrium steady states and/or kinetic conc
- understand the chemical-physical aspects of our world and critically interpret the econimic systems in the framwork of these scientific laws

Making Judgements (Dublin Descriptor 3)
At the end of the course, the student will be able to:

- Identify which non-renewable resources are the most critical ones and will be the most critical ones
- Identify the impact of externalities om the environment and humans
- Identify strategies for minimizing socio-economical-environmental negative effects
- Examine the LCA assessment with applying an appropriate scientific method to interpret data
- Independently choose the most appropriate methodological, technological, or modeling approach to assess and solve problems related to non-renewable resources
- Ability to integrate economic needs into an interdisciplinary framework (chemistry, biology, geology, ecology, physics, law, economics) to address complex environmental problems
- Ability to critically analyze scientific literature and technical-regulatory documents

- Ability to independently evaluate policies, plans, and programs in the air sector (legal, economic, energy), including in terms of sustainability and the UN Agenda 2030
- Ability to independently develop the project and methodology for the final exam, critically evaluating the results obtained and integrating them with scientific literature.

Communication Skills (Dublin Descriptor 4)
At the end of the course, the student will be able to:

- Be able to clearly and concisely explain, with appropriate language, the main environmental issues related to non-renewable resources
- Be able to clearly and concisely explain, with appropriate language, the main effects of environmental externalities on humans, the environment, climate
- Ability to interact and collaborate with third parties.

Learning Skills (Dublin Descriptor 5)
At the end of the course, the student will be able to:

- Be able to apply acquired knowledge to determine the best practices in future policies
- Be able to apply the acquired knowledge to new areas, different from those covered in the course, independently integrating it with other sources of knowledge.
- Consult international scientific literature, databases, and technical reports from research centers, local authorities, governments, and international organizations.
- Work both in groups and independently, using the scientific method as a working tool

Contents

Contents
• Definition of abiotic resources and raw materials.
• Understand the concept of non-renewable resources and their environmental impacts
• Responsible and sustainable use of non-renewable resources such as metals, aspects of recycling within a circular economy
• Learn about resource efficiency and circularity and its importance in sustainable development
• Understand the concept of planetary boundaries in relation to abiotic and non-renewable sustainable resource management
• Analyse case studies and real-world examples of sustainable resource management
• Learn about life cycle assessment and its role in relation to planetary boundaries, addressing relative and absolute sustainability concepts
• The main EU and international policies linking resources, supply chains assessment, planetary boundaries and sustainability.

Detailed program

Detailed program
• Definition of abiotic resources, availability, supply risk, demand in main sectors and technologies
• Distribution of elements across various environments using (anthro)biogeochemical cycles
• Sustainable mining activities
• Global trends and challenges in non-renewable resource management
• Definition and importance of resource efficiency
• Strategies for improving resource efficiency and circularity (reduce, reuse, recycle, etc.)

• Key concept of circular economy, including recycling, downcycling and upcycling
• Description of the challenges associated with the recycling and reuse of various materials, including precious metals, concept of urban mining
• Abiotic resources and associated environmental impacts due to extraction, use, and waste management
• The integration of sustainable processes within the circular economy
• The novel entities
• Introduction to life cycle assessment (LCA) methodology and supply chain assessment for sustainable resource management
• Relevance of planetary boundaries to sustainable resource management
• Overview of EU and international policies for sustainable resource management (e.g. Circular Economy Package, critical Raw Materials Act) and link with planetary boundaries (e.g. 8th Environmental Action Program “Living well within the limits of our Planet”)
• Overview of EU and international policies for supply chain assessment
• International cooperation and global governance of sustainable resource management
• Case studies on key sectors and technologies

Prerequisites

The needed prerequisites or the required reviews are:

- Basic understanding of environmental science
- Basic understanding of sustainability concepts
- Basic understanding of Inorganic and Organic chemistry
- Basic understanding of Thermodynamic
- Basic understanding of Economic systems

Teaching form

4 CFUs of mixed theoretical and interactive lessons (32 hours):
• 8 two-hour lectures, in person, mostly frontal teaching and discussion in class, Delivered Didactics
• 4 two-hour lectures, online, mostly frontal teaching and discussions, Delivered Didactics.
• 4 two-hour lectures, in person, including group presentations, group debates, discussion of relevant caselaw and reading of relevant material in class, Interactive Teaching. Attendance to lectures and interactive exercises is highly recommended.

Textbook and teaching resource

Textbook and teaching resource
• United Nations Environment Programme (2024): Global Resources Outlook 2024: Bend the Trend – Pathways to a liveable planet as resource use spikes. International Resource Panel. Nairobi. https://wedocs.unep.org/20.500.11822/44901
• World Economic forum (2025) 2025 Global risk report https://www.weforum.org/publications/global-risks-report-2025/
• Juan F. Velasco-Munoz, Chaudhery Mustansar Hussain (2021) Sustainable Resource Management: Modern Approaches and Contexts. Elsevier ISBN: 9780128243428
• Hauschild, M. Z., Rosenbaum, R. K., & Olsen, S. I. (2018). Life cycle assessment Springer International

Publishing, Cham. https://doi. org/10.1007/978-3-319-56475-3.
• Slides
• Notes shown during lectures and additional material on selected topics, i.e., scientific articles, made available on the e-learning website of the course.

Semester

I semester (October - January)

Assessment method

The final exam consists of a single written exam at the end of the course, which comprises the discussion of various topics covered in the course within the three modules, with an emphasis also on the connections between concepts and processes, such as to arrive at a critical evaluation of work from the point of view of planetary boundaries and responsible use of renewable and non–renewable resources. The final exam could include in-group activities focusing on the presentation and discussion of assigned case studies.
The assessment will evaluate the student's ability to understand and integrate the knowledge acquired in the three modules, critically discuss case studies, use appropriate scientific terminology, and provide a reasoned evaluation in relation to planetary boundaries and the responsible use of renewable and non-renewable resources.
The final score will be between 18/30 and 30/30 cum laude, based on the overall assessment considering the following criteria:

- knowledge and understanding;
- ability to connect different concepts;
- autonomy of analysis and judgement;
- ability to correctly use scientific language

Office hours

Prof. Luca Ferrero receives the students by appointment via e-learning or by email at luca.ferrero@unimib.it

Sustainable Development Goals

AFFORDABLE AND CLEAN ENERGY | INDUSTRY, INNOVATION AND INFRASTRUCTURE | SUSTAINABLE CITIES AND COMMUNITIES | RESPONSIBLE CONSUMPTION AND PRODUCTION | CLIMATE ACTION