



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Biomass As Renewable Resource

2627-1-F7603Q005-F7603Q00503

Aims

General aims

The module 'Biomass as renewable resource' aims at providing knowledge and skills regarding the potential of plant biomass as feedstock, with a major focus on challenges and opportunities for its sustainable use in agriculture and industry for the production of bio-energy and bio-products through a circular economy approach. Classes will provide basic knowledge of plant biology and ecology, necessary to understand the factors determining the direct and indirect importance of plant biomass as feedstock for energy supply and other uses. Characteristics of biomass and valorization pathways will be taught. Students will learn limits and benefits in the use of different types of biomass in the light of social and environmental issues related to global change. In this regard, the role of biomass as a key component in the circular economy will be analyzed. The cascading use as efficient utilization of residues and waste materials to extend biomass availability will be discussed also through case studies. Case studies will be analysed and discussed during sessions common to the other two modules to provide the necessary interdisciplinary understanding of the topics covered in the course.

Knowledge and understanding

By the end of the course, students will have developed a fundamental understanding of the following:

- renewable resources in the global change era;
- the importance of biomass as a renewable resource;
- main EU and international policies regarding biomass use as a renewable resource;
- basics of plant biology and ecology in relation to sustainable biomass valorization;
- classification of biomass based on origin, characteristics and sustainability;
- pathways and processes of biomass valorization in the productive and energy supply chains;
- the role of biomass in the circular economy;
- challenges and opportunities in the cascading use of biomass as feedstock;
- real-world examples of sustainable biomass management in the productive and energy supply chains.

Applied knowledge and understanding

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

- discuss traditional and emerging renewable products derived from biomass;

- discuss the sustainability of bioproducts derived from biomass;
- identify the potential environmental and socio-economic externalities associated with unsustainable biomass production and use;
- propose sustainable valorization strategies based on valuable compounds obtained from biomass;
- discuss biological and ecological mechanisms and plant strategies relevant to the sustainable use of biomass;
- critically analyse the evolution of biomass use as a renewable resource in response to changing energy and environmental challenges at national and supranational levels;
- evaluate biomass valorization strategies from a circular economy perspective;
- interpret economic and productive systems in the light of biological and ecological constraints.

Making judgements

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

- critically evaluate the potential, limitations and sustainability of different types of biomass as renewable feedstock;
- assess the suitability of different biomass valorization pathways according to biomass origin, composition, availability and environmental constraints;
- compare alternative uses of biomass by considering energetic efficiency, production of bioproducts, circular economy principles and cascading use;
- critically analyse the environmental, social and economic implications associated with biomass production, transformation and use;
- identify potential trade-offs and conflicts related to biomass exploitation, including competition with food production, land-use change, biodiversity conservation and resource depletion;
- evaluate case studies of biomass management and valorization, identifying strengths, weaknesses and possible improvements;
- formulate reasoned opinions on the role of biomass in renewable energy strategies and in the transition towards more sustainable production systems;
- integrate biological, ecological, technological and socio-economic information to support informed decisions on sustainable biomass use.

Communication skills

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

- use appropriate scientific terminology to describe biomass types, characteristics and valorization pathways;
- clearly communicate the environmental, biological and socio-economic implications of biomass use;
- present and discuss case studies of biomass management and valorization in a structured and critical way;
- interact with third parties during interdisciplinary discussions, supporting arguments with scientific and technical evidence.

Learning skills

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

- independently deepen knowledge on biomass valorization, renewable resources and circular economy;
- critically consult scientific, technical and policy-related sources on biomass use and sustainability;
- integrate new information from different disciplines to analyse biomass-related issues;
- apply the acquired knowledge to further studies or professional contexts related to sustainable resource management, bioenergy and bioproducts.

Contents

The module will cover:

- biomass as a renewable resource in the global change era;
- plant biomass as feedstock for bioenergy and bioproducts;
- biological and ecological basis for the sustainable use of biomass;
- classification of biomass according to origin, characteristics and sustainability;
- main biomass valorization pathways in productive and energy supply chains;

- biomass use within circular economy and cascading-use approaches;
- environmental and socio-economic implications of biomass production and use;
- case studies of sustainable biomass management and valorization.

Detailed program

- Renewable resources in the global change era.
- Biomass as a renewable resource: definitions, relevance, potential and limitations.
- Main EU and international policies concerning biomass use, renewable resources, bioenergy and circular economy.
- Basic concepts of plant biology and ecology relevant to the sustainable use and valorization of biomass.
- Classification of biomass according to origin, composition, availability, characteristics and sustainability.
- Main types of biomass feedstock: dedicated crops, agricultural residues, forestry biomass, agro-industrial by-products and organic waste streams.
- Pathways and processes for biomass valorization in productive and energy supply chains.
- Biomass conversion into bioenergy and bioproducts: main processes, products and sustainability issues.
- Biomass in circular economy and sustainable production systems.
- Cascading use of biomass: principles, opportunities and challenges.
- Environmental and socio-economic implications of biomass production, transformation and use.
- Case studies and real-world examples of sustainable biomass management and valorization.

Prerequisites

- Basic notions of biology;
- Basic notions of environmental sustainability.

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.

1 CFU, of mixed didactics in the classroom (16 hours).

- 4 two-hour lectures, in person, including group presentations, group debates, discussion of relevant case studies and reading of relevant material in class, Interactive Teaching.

Textbook and teaching resource

- Slides and notes shown during lectures;
- Scientific articles, technical reports, policy documents and additional material made available on the e-learning website of the course;
- Selected international reports and textbooks on global resource use, sustainability, circular economy, life cycle assessment and sustainable resource management (e.g. Nandabalan, Y.K., et al. (ed.). Zero waste biorefinery.

Springer, 2022.)

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. Chiara Montagnani receives the students by appointment *via* e-learning or by email at chiara.montagnani@unimib.it

Sustainable Development Goals

QUALITY EDUCATION | AFFORDABLE AND CLEAN ENERGY | SUSTAINABLE CITIES AND COMMUNITIES | RESPONSIBLE CONSUMPTION AND PRODUCTION | CLIMATE ACTION | LIFE BELOW WATER | LIFE ON LAND
