TREATY

Course Handbook

Empowering European Universities to Lead Deep Tech Innovation in *Sustainable Energy & Clean Technologies*

Sustainable development and energy-ecological assessment of bioenergy systems

Instructor: Mahdi Tavasoli

Supported by Climate-KIC

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EIT HEI Initiative – Innovation Capacity Building for Higher Education

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Course Information

Sustainable development and energy-ecological assessment of bioenergy systems

Instructor(s): Mykola Tregub, Oksana Kaminetska.

ECTS credits: 2

Course structure:	60 hours
Lecture classes	10 hours
Laboratory classes	10 hours
Personal Activities	40 hours

Mode of delivery: hybrid

Course Summary

The course "Sustainable development and energy-ecological assessment of bioenergy systems" aims to provide a comprehensive study of modern principles of sustainable development in the energy sector, with a focus on bioenergy systems in agricultural production and their energy-ecological assessment. The course integrates an interdisciplinary approach, combining the theoretical foundations of the concept of sustainable development, life cycle assessment (LCA) methodology, and practical aspects of implementing bioenergy systems in the context of decarbonising the economy. As a result of studying the course, participants will gain knowledge about the concept of sustainable development in energy, learn about the principles of decarbonisation of the economy and the transition to renewable energy sources, master life cycle assessment (LCA) methods, and gain an understanding of the types of biomass, biofuels and the technological chains of their production. Students will acquire practical skills in performing energy balance analyses, calculating energy and environmental indicators, greenhouse gas emissions (CO_2, CH_4, NO_X), energy efficiency, CO2 equivalents, and assess the life cycle of bioenergy systems from raw material production to waste disposal.

The competencies developed during the course will enable participants to work effectively in the field of renewable energy, environmental consulting, energy project management, and contribute to the achievement of sustainable development goals.

Course Participants

This course is designed for a diverse audience, including both higher education students and professionals interested in the principles of sustainable development in the energy sector, with a focus on bioenergy technologies.

Потенційними учасниками є:

- ✓ First, second and third level higher education students in engineering, agronomy or related fields who wish to expand their knowledge of the fundamentals of sustainable development and the use of renewable energy sources;
- ✓ specialists and practitioners from relevant industries (manufacturing, automation, logistics, energy, etc.) who seek to improve their skills in the application of renewable energy sources and innovations in production;
- ✓ academic and non-academic staff of research institutes, universities and companies interested in research on bioenergy systems, sustainability indicators and reducing anthropogenic impact on the environment.

Prerequisites:

- ✓ a basic understanding of engineering and production systems would be an advantage;
- ✓ in-depth knowledge of engineering is not required, but participants should be interested in alternative energy sources, sustainable technologies, and innovations in industrial practice;
- ✓ The course is open to participants with diverse disciplinary and professional backgrounds, and a willingness to work in an interdisciplinary environment will be an advantage.

Learning Outcomes

Upon completion of the course, participants will be able to:

1) conduct a comprehensive energy and environmental assessment of bioenergy systems using the LCA methodology;
2) analyse the energy balances of enterprises and determine the potential for implementing renewable energy sources;
3) assess the impact of production systems on the environment by calculating greenhouse gas emissions (CO_2, CH_4 NO_X)and energy indicators;
4) compare alternative energy scenarios based on economic, energy and environmental criteria;
5) create technical and economic justifications for bioenergy projects, taking into account the principles of sustainable development;
6) assess the feasibility of replacing traditional energy sources with bioenergy alternatives;
7) apply the principles of sustainable development to the planning of energy systems in production.

Assessment

In order for each participant to complete successfully the course and be awarded the corresponding ECTS credits, they must pass the course assessment. The outcome of the assessment can be either Pass or Fail.

Assessment methods

- Exam. 30 different topics are offered to assess the obtained by the participants' competencies. The content of the exam work includes: topic importance, description of state-of-the-art level of technologies and modern practical trouble killers, tendencies of development. An exam work

must include schemes, formulas, plots, text, etc. Number of words > 500. Provided calculations benefit an exam work. The proper format: A4, 14 pt + Times New Roman.

Assessment Methods	Examples of Assessment
• Demonstrate a deep understanding of the concept of sustainable development in energy, the principles of decarbonisation and energy transition in the context of the Sustainable Development Goals (SDG 7).	Exam + Oral presentation
• Distinguish between types of biomass, types of biofuels and technological chains for their production, taking into account energy and environmental indicators.	Exam + Oral presentation
• Conduct a comprehensive analysis of the energy balances of enterprises, determine the share of renewable energy sources and build energy profiles.	Exam + Report
• Calculate the energy and environmental indicators of bioenergy systems: greenhouse gas emissions (CO_2, CH_4, NO_x), , energy efficiency, CO_2 equivalent.	Exam + Report
• Perform a comparative analysis of different types of fuel based on environmental and energy criteria.	Exam + Oral presentation
• Critically analyse the impact of energy decisions on the environment and sustainable development in the long term.	Exam + Quiz

Mentoring

As part of the course, participants will receive support and guidance from a mentor while completing an individual assignment/project and will gain practical experience in collecting and analysing information and selecting the best technologies for achieving sustainable development goals. Taking into account their own experience and interests, students can deepen their knowledge in the following areas:

- ✓ applied research based on comprehensive energy and environmental assessment of bioenergy systems using LCA methodology;
- ✓ research based on determining the potential for implementing bioenergy technologies;
- ✓ research on the impact of energy systems on the environment through the calculation of greenhouse gas emissions (CO_2, CH_4, NO_X);
- ✓ research on determining the life cycle of biofuels from raw material production to final consumption

This component of mentoring ensures that each participant develops practical skills while adapting the learning outcomes to their individual professional or academic goals.

Bibliography

1. Thornley, P., & Adams, P. (2018). *Greenhouse Gas Balances of Bioenergy Systems*. Academic Press. ISBN: 978-0-08-101036-5
2. Kaltschmitt, M., Hartmann, H., & Hofbauer, H. (2016). *Energie aus Biomasse: Grundlagen, Techniken und Verfahren* (3rd ed.). Springer. ISBN: 978-3-662-47437-2
3. Brandão, M., Azzi, E., Novaes, R. M. L., & Cowie, A. (2021). The modelling approach determines the carbon footprint of biofuels: the role of LCA in informing decision makers in government and industry. Cleaner Environmental Systems, 2, 100027. https://doi.org/10.1016/j.cesys.2021.100027
4. Creutzig, F., Ravindranath, N. H., Berndes, G., et al. (2015). Bioenergy and climate change mitigation: an assessment. GCB Bioenergy, 7(5), 916-944. https://doi.org/10.1111/gcbb.12205
5. ISO 14040:2006. Environmental management — Life cycle assessment — Principles and framework. International Organization for Standardization. https://www.iso.org/standard/37456.html
6. ISO 14044:2006. Environmental management — Life cycle assessment — Requirements and guidelines. International Organization for Standardization. https://www.iso.org/standard/38498.html

Other Important Information

Course evaluation: Upon successful completion of the course, participants are required to fill in the course evaluation questionnaire.

Certificate: Upon successful completion of the course, participants will be issued a certificate of achievement provided by The Cyprus Institute and EIT Climate KIC.

Plagiarism: CyI has explicit rules concerning academic dishonesty including plagiarism. Course participants are reminded that all work submitted as part of the requirements for any examination (including coursework) of CyI must be expressed in their own words and incorporated in their own ideas and judgements.

Course Timetable

Session	Date and Time	Instructor	Venue
1st	October 20th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1
2nd	October 21th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1
3rd	October 22th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1
4th	October 23th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1
5th	October 24th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1

6th	October 27th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1
7th	October 28th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1
8th	October 29th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1
9th	October 30th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1
10th	October 31th, 15.25-16.45	Mykola Tregub, Oksana Kaminetska	Auditorium 31, Campus 1

Contact Details of Instructor(s)

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