TREATY

# Course Handbook

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

## Digital technologies in distributed bioenergy

Supported by eit Climate-KIC

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# Course Information

Digital technologies in distributed bioenergy

Instructor(s): Viacheslav Chuba, Ivan Omarov.

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

This course aims to equip participants with modern knowledge and practical skills in the field of digital transformation of the energy sector, particularly bioenergy systems. Participants will study the architecture and operating principles of distributed energy systems (Smart Grid), digital monitoring platforms, IoT technologies, automation systems, and energy data analytics. Special attention is paid to the integration of Renewable Energy Sources (RES) into local microgrids, digital methods of load balancing and energy management, and the assessment of the energy-ecological sustainability of bioenergy systems.

The course is interdisciplinary in nature, combining energy, information, and analytical technologies.

hrough practical assignments, participants will master tools for digital modeling, system efficiency analysis, and the implementation of intelligent algorithms in bioenergy.

## Course Participants

This course is designed for a diverse audience, including both students and specialists interested in digital innovations in the energy sector, modeling of energy processes, the development of bioenergy, and the integration of RES into existing power systems.

Potential participants are:

- ✓ Bachelor's, Master's, or Doctoral level students in engineering, agronomy, or related fields who wish to master digital approaches to designing and analyzing energy systems;
- ✓ Specialists and practitioners from industry (manufacturing, automation, logistics, energy, etc.) who work with bioenergy technologies and seek to improve their skills in the application of renewable energy sources;

- ✓ Academic and non-academic staff of research institutes, universities, and companies who study the interaction of digital systems and are interested in research on bioenergy systems and renewable energy sources.

**Prerequisites:**

- ✓ It is desirable to have initial skills in working with analytical tools and an interest in the topic of sustainable energy development, digitalization, and innovations in the energy sector;
- ✓ A basic understanding of engineering, electrical engineering, and automation of production processes will be an advantage;
- ✓ The course is open to participants with diverse disciplinary and professional backgrounds, and a readiness to work in an interdisciplinary environment will be an advantage.

## Learning Outcomes

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

1) Explain the principles of digitalization of energy systems and the role of Smart Grid in bioenergy;
2) Apply digital platforms for collecting and processing energy data;
3) Analyze the structure and functions of energy process management systems;
4) Model the integration of RES into local energy networks;
5) Evaluate the effectiveness of digital energy resource monitoring systems;
6) Calculate sustainability indicators of bioenergy systems ((energy efficiency, $CO_2$ emissions);
7) Develop concepts for digital solutions to increase the efficiency and reliability of energy supply.

## 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 |
|---|---|
| • Explain the principles of digitalization of energy systems and the role of Smart Grid in bioenergy; | Exam + Oral Presentation |
| • Apply digital platforms for collecting and processing energy data; | Exam + Oral Presentation |

| | |
|---|---|
| • Analyze the structure and functions of energy process management systems; | Exam + Report |
| • Model the integration of RES into local energy networks; | Exam + Report |
| • Evaluate the effectiveness of digital energy resource monitoring systems; | Exam + Oral Presentation |
| • Calculate sustainability indicators of bioenergy systems (energy efficiency, $CO_2$ emissions); | Exam + Quiz |

## Mentoring

As part of the course, participants will receive individual mentoring during the completion of their assignment/project, or gain practical experience in modeling the Smart Grid, assessing the potential of RES, developing solutions for energy resource monitoring, or evaluating the sustainability of bioenergy systems.

Depending on their experience and interests, they may focus on areas such as:

- ✓ Applied research based on conducting a comprehensive energy-ecological assessment of bioenergy systems using the LCA methodology;
- ✓ Research based on determining the potential for implementing bioenergy technologies;
- ✓ Modeling microgrid indicators with RES integration;
- ✓ Development of energy monitoring systems based on IoT;
- ✓ Creation of a digital energy analysis dashboard.

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

## Bibliography

1. Kumari, N., Sharma, A., Tran, B., Chilamkurti, N., & Alahakoon, D. (2023). A comprehensive review of digital twin technology for microgrids and power systems. Energies, 16(14), 5525. https://doi.org/10.3390/en16145525

2. International Electrotechnical Commission (IEC). (2024). How digital twins will revolutionize the energy sector [White paper]. Geneva: IEC.

3. Djandja, O. S., Etuk, S., & Okoro, O. I. (2025). Bridging bioenergy and artificial intelligence for sustainable energy systems. Energies.

4. Asthana, A., Rai, A. K., Gupta, D., & Yadav, R. (2025). Smart bio-energy: A review of IoT-integrated biogas power generation systems [Preprint].

5. Hida, S. N., Prabowo, S., Kirom, M., & Suhendi, A. (2023). Monitoring system of biogas production volume and control – IoT approach. In Proceedings of the 10th International Conference on Green Energy and Technology.

6. Zhou, Y., Liu, J., Chen, R., & Zhang, T. (2024). Advances in emerging digital technologies for energy efficiency and integration: A review. Renewable Energy Systems Reviews, 185, 112345. https://doi.org/10.1016/j.rser.2024.112345

7. Rabaia, M. K. H., El-Sayed, M. A., Abdelkareem, M. A., Olabi, A. G., & Sayed, E. T. (2025). Digital twin-driven sustainable energy life cycles. Journal of Cleaner Production, 450, 140765. https://doi.org/10.1016/j.jclepro.2025.140765

8. Industrial and Technical Articles. (2023–2025). IoT-based biogas monitoring and smart control systems using GSM/ESP32/Cloud technologies. International Journal of Progressive Research / Preprints. Retrieved from https://www.preprints.org

9. Lysenko, V., Voitenko, V., & Kulyk, I. (2023–2025). Ukrainian developments in IoT-based monitoring systems for biogas and bioenergy applications. Technical Science Journal.

## 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 | November 3th, 12.00-13.20 | Ivan Omarov Viacheslav Chuba, | Auditorium 309, |
| 2nd | November 4th, 12.00-13.20 | Ivan Omarov Viacheslav Chuba, | Auditorium 315, |
| 3rd | November 5th, 12.00-13.20 | Ivan Omarov Viacheslav Chuba, | Auditorium 309, |
| 4th | November 5th, 13.35-14.55 | Ivan Omarov Viacheslav Chuba, | Auditorium 315, |
| 5th | November 7th, 12.00-13.20 | Ivan Omarov Viacheslav Chuba, | Auditorium 309, |
| 6th | November 10th, 12.00-13.20 | Ivan Omarov Viacheslav Chuba, | Auditorium 315, |
| 7th | November 11th, 12.00-13.20 | Ivan Omarov Viacheslav Chuba, | Auditorium 309, |
| 8th | November 12th, 12.00-13.20 | Ivan Omarov Viacheslav Chuba, | Auditorium 315, |
| 9th | November 13th, 13.35-14.55 | Ivan Omarov Viacheslav Chuba, | Auditorium 309, |
| 10th | November 14th, 8.15-9.35 | Ivan Omarov Viacheslav Chuba, | Auditorium 315, |

## Contact Details of Instructor(s)

| Name | Email | Telephone number |
|---|---|---|
| Ivan Omarov | omarov.ivan@gmail.com | +380504630361 |
| Viacheslav Chuba | vvchuba@ukr.net | +380961332665 |

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