

RENEWABLE ENERGY SOURCES IN AGRICULTURE

COURSE OUTLINE

1. GENERAL			
SCHOOL	School of Agricultural Sciences		
ACADEMIC UNIT	Department of Agriculture		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	0810.8.004.0	SEMESTER	2nd
COURSE TITLE	Renewable Energy Sources in Agriculture		
INDEPENDENT TEACHING ACTIVITIES if credits are awarded for separate components of the course	WEEKLY TEACHING HOURS		CREDITS
Total			5
COURSE TYPE general background, special background, specialised general knowledge, skills development			
PREREQUISITE COURSES	Agricultural Waste Management		
LANGUAGE OF INSTRUCTION and EXAMINATIONS	English		
OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			
2. LEARNING OUTCOMES			
Learning outcomes			

This course provides students with fundamental knowledge of energy resources, with a particular emphasis on renewable energy sources. It focuses on geothermal energy and biomass technologies, combining theoretical instruction with practical training through laboratory sessions and hands-on exercises.

Upon successful completion of the course, students will be able to:

- Develop a comprehensive understanding of the global and national energy landscape.
- Evaluate and design geothermal energy systems for agricultural applications.
- Assess the environmental impacts associated with geothermal energy exploitation and make informed decisions based on technical, economic, and environmental considerations.
- Understand the properties of biomass and its energy production potential from land-related biomass resources, particularly agricultural residues.
- Identify agricultural residues suitable for combustion and the production of thermal and electrical energy.
- Identify agricultural residues suitable for biogas production through anaerobic digestion.
- Evaluate the performance of anaerobic digestion processes using key operational parameters, such as biogas composition, pH, volatile fatty acids (VFAs), and other monitoring indicators.
- Calculate the heating requirements of agricultural facilities using biomass-based energy systems.
- Design, size, organize, and operate anaerobic digestion plants treating one or more agricultural residues.
- Understand the principles and processes of geothermal energy utilization and biomass conversion technologies (combustion and anaerobic digestion), as well as their relationship with agricultural land, agricultural residues, and their sustainable utilization.
- Develop the ability to work both independently and collaboratively, preparing them for interdisciplinary and international professional environments while fostering the creation of new knowledge.
- Demonstrate respect for the natural environment through the design of energy production systems with minimal environmental impact.
- Make informed decisions regarding the optimal use of geothermal energy and available biomass resources for sustainable energy production.

General Competences

- Searching for, analyzing, and synthesizing data and information using appropriate technologies
- Decision-making
- Independent work
- Teamwork

3. SYLLABUS

The course is divided into two main parts.

Part I: Geothermal Energy

1. The current energy landscape and the future of energy; the energy situation in the European Union; future energy perspectives; and the Greek energy system.
2. Agriculture as an energy producer: energy inputs and outputs in agricultural systems.
3. Natural gas and renewable energy sources in agriculture.
4. Geothermal energy: formation of geothermal fields, geothermal gradients, and classification of geothermal resources.
5. Geothermal energy worldwide and the geothermal resources of Greece.
6. Agricultural applications of geothermal energy, including greenhouse and soil heating, aquaculture, and geothermal heat pumps.
7. Environmental impacts associated with geothermal energy exploitation.
8. Site selection criteria for geothermal energy production facilities.
9. Advantages and limitations of geothermal energy utilization.

Part II: Biomass Energy

10. Biomass and Biomass Potential: Introduction to biomass as a renewable energy resource, with emphasis on the energy potential of agricultural residues and other biomass feedstocks.
11. Biomass Conversion Processes: Overview of biomass conversion technologies, focusing on thermochemical conversion (combustion) and biological conversion through anaerobic digestion for biogas production.
12. Biomass Combustion: Principles of biomass combustion, including the stages of the combustion process, the influence of biomass characteristics (moisture content, ash content, and particle size), and biomass combustion systems.
13. Anaerobic Digestion and Influencing Factors: Fundamentals of the anaerobic digestion of agricultural residues, including the microbiology of the process, key operational parameters (temperature, pH, alkalinity, nutrients, and inhibitory compounds), and current technological applications.
14. Design and Sizing of Biomass Energy Systems: Theoretical concepts supported by practical examples and engineering exercises on the design and sizing of biomass energy conversion systems, with particular emphasis on anaerobic digestion facilities.
15. Heating Demand Calculations for Agricultural Facilities: Application of engineering principles and problem-solving exercises for calculating the heating requirements of agricultural facilities, such as greenhouses, using biomass-based energy systems.

4. TEACHING and LEARNING METHODS - EVALUATION						
DELIVERY Face-to-face, Distance learning, etc.	The course is delivered through face-to-face instruction, including lectures in the lecture hall and practical sessions in the laboratory.					
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY Use of ICT in teaching, laboratory education, communication with students	• PowerPoint presentations and other audiovisual materials are used to support lectures. • The learning process is supported through the University's e-Class learning management system. • Communication with students is carried out via e-mail through the e-Class platform					
TEACHING METHODS The manner and methods of teaching are described in detail.	<table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Course total</td><td></td></tr></table>		Activity	Semester workload	Course total	
Activity	Semester workload					
Course total						
STUDENT PERFORMANCE EVALUATION Description of the evaluation procedure	Student assessment consists of a final written examination and two optional short mid-term tests (quizzes), the combined score of which contributes 30% to the final course grade. The written examinations include a combination of essay questions, multiple-choice questions, true/false questions, and matching exercises. The laboratory component is assessed separately. The laboratory grade is based on the student's performance in the compulsory written laboratory examination (60%) and on laboratory reports and presentations of experimental results (40%).					

5. ATTACHED BIBLIOGRAPHY
• Bioenergy Production by Anaerobic Digestion, Korres N., O' Kiely P., Benzie J. Taylor & Francis Ltd, ISBN 0415698405 • Biogas from Waste and Renewable Resources, Dieter Deublein, Angelika Steinhauser, Wiley-VCH Verlag GmbH, ISBN 352732798

