

## Renewable energy production and use SYLLABUS

**Study subject No:** 3.2.

**Responsible Unit:** JAMK University of Applied Sciences (JAMK)

**Credits and distribution of academic hours\*:**

	Credits ECTS	Contact hours		Independent study hours	Total hours
		Lectures	Practical works or seminars		
JAMK	5.5	26	23	116	165
LBTU	1.5	8	6	31	45
<b>Total</b>	<b>7</b>	<b>34</b>	<b>29</b>	<b>147</b>	<b>210</b>

\* 1 ECTS = 30 hours (9 contact hours and 21 independent hours);

1 academic hour = 40 minutes;

Theoretical lectures not less than 50% of contact hours.

**Course developers:**

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**Notes:** General study course for the master programme Bioeconomy.

**Prior knowledge:** “Environmental economics” and “Circular economy”.

**Annotation:** Provides knowledge of energy mix in Uzbekistan, as well as renewable energy relevance in energy system nationally and globally. Provides information about different kind of sustainable bioenergy (sources, production, refining and use); integration of bioenergy to other modern renewable energy systems; valorisation and treatment of bio based waste streams; and closing the life-cycle loop of products and materials by keeping their value in the economy as long as possible. The focus is in (1) sources of renewable energy, (2) characterization of biomass to detect more valuable products to optimize the purpose of use; (3) processing and refining of low value biomasses; (4) variety of conversion technologies in renewable energy in different scales, and (5) resource efficiency and emission control in renewable energy production chain.

**The aim:** After completing this course student will know the renewable energy part in national energy system, and significance and possibilities in industry and in communities. Student understands the sources of renewable energy as well as the distribution of energy consumption to different use. Student knows modern and flexible energy systems related to bioeconomy and the linkage to energy efficiency and circular economy. Student knows biogas production raw materials, production technology and utilization possibilities of final products.

**Description of the organization and tasks of students' independent work:** The student has to complete an independent work about renewable energy technology and waste-based energy raw materials and present it in practicals.

*Learning outcomes (knowledge, skills and competences)*

Learning outcomes	Assessment methods	Levels of achievement		
		Satisfactory	Average	High
<b>KNOWLEDGE</b>				
Students will be able to: demonstrate the comprehensive knowledge about renewable energy sources and steering mechanisms	Discussions in classes, test	Knowledge of the most important relevant steering mechanisms and renewable energy sources, yet there is some difficulty in understanding the whole energy system. 40-69 % of the questions are answered correctly.	Knowledge and understanding of the steering mechanisms, renewable energy sources and the whole energy system. 70-89 % of the questions are answered correctly.	Comprehensive knowledge of the substance in renewable energy sources and critical understanding of the role of steering mechanisms in the whole energy system. 90-100 % of the questions are answered correctly.
Demonstrate the comprehensive knowledge about renewable energy concepts and the processes and technology	Discussions in classes, group and individual work, test	Demonstrate the basic knowledge and understanding about renewable energy concepts and the processes and technology. 40-69 % of the questions are answered correctly.	Demonstrate the sufficient knowledge and understanding about renewable energy concepts and the processes and technology. 70-89 % of the questions are answered correctly.	Demonstrate the comprehensive knowledge about renewable energy concepts and the processes and technology. 90-100 % of the questions are answered correctly.
Demonstrate the comprehensive understanding about the linkage of renewable energy to energy efficiency and circular economy	Discussions in classes, individual work, test	Demonstrate some understanding about renewable energy linkage to energy efficiency and circular economy. 40-69 % of the questions are answered correctly.	Demonstrate sufficient understanding about renewable energy linkage to energy efficiency and circular economy. 70-89 % of the questions are answered correctly.	Demonstrate comprehensive understanding and applications about renewable energy linkage to energy efficiency and circular economy. 90-100 % of the questions are answered correctly.
Demonstrate knowledge and understanding about raw material sources of biogas production, production technology, process and utilization possibilities of final products	Discussions in classes, individual work	demonstrate basic knowledge and understanding about raw material sources of biogas production, production technology, process and utilization possibilities of final products	demonstrate sufficient understanding about raw material sources of biogas production, production technology, process and utilization possibilities of final products	demonstrate in-depth knowledge and understanding about raw material sources of biogas production, production technology, process and utilization possibilities of final products
<b>Professional skills</b>				
Ability to seek and update information about energy system and its changes	Discussions in classes, independent work	Presenting some information and traditions of energy system	Presenting sufficient amount of information about energy system and its changes	Presenting ability to seek and update information about energy system and its changes

Assess the roles of different renewable energy solutions as part of the energy mix	Discussions in classes, independent work	Presenting basic understanding about assessing the roles of some relevant renewable energy solutions and the whole national energy mix	Presenting understanding about assessing the roles of many renewable energy solutions and the whole national energy mix	Ability to assess large number and nationally new renewable energy solutions as part of the energy mix
Ability to assess the biogas production process and its efficiency	Discussions in classes, group work on case study analysis and a presentation	Basic ability to assess the biogas production process and its efficiency	Sufficient ability to assess the biogas production process and its efficiency	Excellent ability to assess the biogas production process and its efficiency
<b>Soft skills</b>				
Work fluently in a group, produce creative solutions and disseminate information about the work findings	Independent/ group work, a presentation	Ability to work and take part producing creative solutions in a group	Ability to work and take active part in producing creative solutions in a group, and in presenting the work	Ability to fluently work and take active part in producing creative solutions in a group, and in presenting work with excellence
Independently obtain, select and systematize necessary information	Independent work	Has sufficient ability to select and systemise the necessary information	Has good ability to obtain and select necessary information, yet there is difficulty in systemizing it	Has convincing ability to obtain, select, systematize necessary information
<b>COMPETENCE</b>				
Comprehensive understanding of the state of renewable energy internationally and possibilities of renewable energy solutions nationally as part of the energy mix	Discussions in classes, individual work, test	Understanding based on theoretical information and only some basic examples about renewable energy.	Sufficient understanding about most relevant renewable energy solutions internationally and ability to suggest some relevant ways to develop renewable energy nationally.	In-depth understanding about most renewable energy solutions internationally and ability to suggest ways to develop renewable energy nationally.
Comprehensive understanding of the biogas production process and ability to suggest ways for optimisation of biogas production	Discussions in classes, group work on case study analysis and a presentation	Basic understanding of the biogas production process and ability to suggest ways for optimisation of biogas production.	Sufficient understanding of the biogas production process and ability to suggest ways for optimisation of biogas production.	In-depth understanding of the biogas production process and ability to suggest ways for optimisation of biogas production .

**Requirements for awarding credit points:** The student has to pass the test, as well as complete and submit practical assignments performed during practicals, and to complete the group and individual assignments.

### ***Knowledge assessment and prerequisites for taking a test or examination***

The final mark in the course is based on cumulative score: Activity during lectures (10 %), activity during practicals/seminar (20 %), group work and a report (20 %), individual independent work and a presentation (20 %), and a test (30 %).

*\* 10 percent are equal to one point on a 10-point marking scale (or 10 percent are equal to 0.5 point on a 5-point marking scale).*

Topic	Type of assessment	Percentage	Assessment deadline
Activity in lectures	Participation and activity in discussions	10 %	During the entire semester
Activity in practicals/seminar classes	Practical assignments during classes and at home	20 %	During the entire semester
Group work and presentation - case study analysis about biogas production	Workgroup work and presentation	20 %	Within the specified time for the presentation
Individual work about renewable energy sources, renewable energy production technologies and processes	Individual independent work	20 %	Within the specified time for the presentations
Topics 1-10	Test	30 %	Within the specified time for the test
Total		100	-

### ***The course contents***

#### ***1. Lectures***

1. Basics of the national energy system including renewable energy and operating environment.
2. Global challenges and steering mechanisms relating to energy and climate issues.
3. Theory of production technologies and raw materials in renewable energy sources including bio, water, wind and solar energy technologies and use. Basics of hybrid systems.
4. Energy consumption in different use, energy efficiency significance.
5. Modern and flexible energy grids and storage.
6. Renewable energy as part of circular economy. Life-cycle perspective to material use. Industrial symbiosis as one solution to circular economy.
7. Valorisation and treatment of bio-based waste streams in renewable energy production. Different bioeconomy sectors.
8. Raw materials for biogas production, production technologies and processes, both in centralized and in decentralized scale. Sustainable and efficient production of biogas, cogeneration and utilisation of energy and heat. The use of digestate for fertilization. Economic aspects of biogas production.
9. Biogas refining and use in households, industry and transportation.
10. Principles of emission control in renewable energy production.
11. Examples of renewable energy supply chains, e.g. energy crops.

## 2. *Practicals*

1. Getting acquainted about national energy system (steering and energy system), base work and discussion.
2. A study trip/visit in renewable energy related company.
3. The start of group project work + producing a report about chosen renewable energy production technology.
4. Workshop during classes about renewable energy as part of circular economy.
5. The start of individual project work + seminar about waste based raw materials from chosen bioeconomy sector suitable for energy production.
6. Group work and presentation - a case study analysis about biogas production and presentation of the findings about the biogas production process and suggestions for its optimisation.

### **List of sources of training, methodological and scientific literature and information**

#### ***Compulsory reading (books, scientific articles, online sources etc.):***

1. Renewable energy. European Commission website.  
[https://ec.europa.eu/energy/topics/renewable-energy\\_en](https://ec.europa.eu/energy/topics/renewable-energy_en)
2. Key World Energy Statistics 2021. International Energy Agency. 2021.  
<https://www.iea.org/reports/key-world-energy-statistics-2021>
3. Sa Rosa, Aldo Vieira. Fundamentals of Renewable Energy Processes. Third Edition. Elsevier. 2012.
4. Van Swaaij, W., Kersten, S., Palz, W. Biomass power to the world: Transformations to Effective Use. Pan Stanford Publishing. 2015.
5. Bhatia, S., C.; Gupta, R., K. Textbook of renewable energy. Woodhead Publishing. 2018.
6. Wellinger, A., Murphy, J. and Baxter, D., editor(s). The biogas handbook: Science, production and applications. Cambridge (United Kingdom): Woodhead; 2013. JRC78872
7. The most suitable strategic papers in Uzbekistan related to renewable energy

#### ***Further reading:***

1. Renewable Energy prospects for the European union. International Renewable Energy Agency. 2018.  
<https://www.irena.org/publications/2018/Feb/Renewable-energy-prospects-for-the-EU>
2. European Biogas Association, publications about biogas: <https://www.europeanbiogas.eu/category/publications/>

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