

# ENERGY EFFICIENCY AND GREEN ENERGY

## DESCRIPTION OF THE COURSE

Item	Field of knowledge, the direction of training, education and qualification level	Course	
		<b>Full-time education</b>	
Credit: 3	Field of knowledge <u>"Natural Sciences"</u>  Specialty <u>102 "Chemistry"</u> (code and name)  Specialization <u>"Physical Chemistry"</u>	Optionally	
Module: 2		<b>Years:</b>	
		2-nd	
		<b>Semester:</b>	
Hrs: 90		1-st	
Classroom work: 30hrs Individual work: 60hrs	Educational qualification level: PhD.	<b>Lectures:</b>	
		20 hrs.	
		<b>Practical:</b>	
		10 hrs.	
		<b>Individual</b>	
		60 hrs.	
		<b>Control type: exam</b>	

## AIM AND SCOPES OF THE COURSE

**The purpose of the discipline "Energy efficiency and green energy"** is the obtaining of theoretical knowledge on the production, conversion, and economic consumption of various types of energy, especially from alternative sources.

### **The main tasks of the course:**

- Describe the state and prospects of development of non-traditional and renewable energy sources throughout the world and in Ukraine;
- Learn how to store and transport different types of energy;
- Know the physical and chemical basis of the conversion of solar energy into heat and electricity;
- Understand the environmental consequences of using non-traditional energy sources;
- Assess the prospects for the use of bioethanol and the use of biomass in energy conservation;
- Understand the principles of wind and hydroelectric generation;
- Prospects for the development of hydrogen energy in the world and in Ukraine.

As a result of studying the discipline, graduate students acquire the following competencies:

### **general skills (competencies):**

- Know the structure of fuel and energy balance in Ukraine
- Understand the principles of energy storage, transportation, and use;
- Evaluate the most economically and energy-efficient energy production systems;
- Analyze and harmonize their actions with the legislation in Ukraine in the field of energy-saving.

### **professional skills (competencies):**

- Calculation of power plant efficiency;
- Methods for obtaining hydrogen-gas;
- Construction of photovoltaic cells and technology of their production;
- Principles of the wind farm operation;
- Use of biofuels and production methods;
- Technological schemes of bioethanol production;
- Calculation of ESS system and BESS battery storage system for individual farms;
- Specific problems of energy accumulation and transmission when using various renewable energy sources.

As a result of mastering the discipline, the graduate student must demonstrate knowledge, skills, and abilities relevant to the thematic modules of the discipline:

**To know:**

- Types and prospects of non-traditional and renewable energy sources;
- Current state of the fuel and energy complex in Ukraine;
- General information on energy production, distribution, and consumption systems;
- Environmental problems of various energy facilities;
- Types of non-traditional and renewable energy sources;
- Methods of use, the solar, wind, hydro energy;
- Prospects for the development of hydrogen energy
- Use of biodiesel and biogas in the fuel and energy complex

**To be able:**

- Identify and justify the problem of the energy supply of the facility;
- Use the acquired knowledge in practice;
- Identify the advantages and disadvantages of using green energy;
- Implement safe and cost-effective energy solutions;
- Understand the environmental consequences of using alternative power sources;
- Calculate the yield of biodiesel and understand the methods of its production
- Evaluate the efficiency of power plants;
- Understand the principles of energy storage systems.

## CURRICULUM OF THE COURSE

### **First module. ENERGY AND EFFICIENCY**

#### *Topic 1. Fuel and energy resources of Ukraine.*

Energy development and energy saving in Ukraine. World fuel and energy balance and the place of Ukraine energy system in it. History of development and current state of domestic energy. Fuel and energy balance of Ukraine, available resources and their availability, annual production, and demand. Trends and changes in the level of energy efficiency of energy production. Development of non-traditional and renewable (green) energy sources.

#### *Topic 2. Green or Renewable energy in Ukraine*

Classification of renewable energy sources. Total quantitative indicators and energy resources of non-traditional and renewable sources in Ukraine and the world. The place and integration of green energy into the fuel and energy system of Ukraine. Trends in the level of energy efficiency of energy production.

*Topic 3. Strategy for the development of the energy sector in Ukraine and in the world*

EU and Ukraine goals in the field of energy resource use. Kyoto Protocol. Legislative legal and information base of renewable energy of Ukraine. Energy efficiency in the industry in the context of sustainable development. Formation of a new energy culture of individual and industrial farms and education of a new energy-conscious generation in Ukraine.

#### *Topic 4. Energy consumption and environmental issues*

Energy and its impact on the environment. Atmospheric pollution and the greenhouse effect. Reasons for the use of non-renewable energy. Energy consumption and its accounting. Methods of control and savings. Ways to reduce the use of raw materials in the paradigm of population growth.

#### *Topic 5. Energy storage and storage systems.*

Traditional energy conservation systems and their disadvantages. General ESS systems. BESS battery systems. PHS hydraulic accumulators. CAES energy storage systems - compressed air storage. Grid systems and frequency control of the energy system in Ukraine. Ways of commercialization of energy storage systems.

### **Second module. GREEN (RENEWABLE) ENERGY**

#### *Topic 6. Solar energy in Ukraine.*

Photovoltaic (PV) or solar cells. The principle of operation and methods of calculating the efficiency. Concentrated solar energy systems (CSP). Types of solar power plants (SES) and their place in the energy system. Advantages of solar power plants. Legislation in the field of solar energy in Ukraine. Advantages of commercialization of individual SES in accordance with the legislation of Ukraine.

#### *Topic 7. Wind energy in Ukraine.*

Characteristics of wind and basics of wind energy use. Wind energy resources. Principle of operation and classification of wind turbines. Theory of wind turbine operation. Environmental problems and wind farms. Legislation in

the field of wind energy in Ukraine. Calculation of economic feasibility of using wind farms and their commercialization.

*Topic 8. Hydroelectric power in Ukraine.*

Hydro accumulators and hydroelectric power plants (HPP). Principle of operation and classification of HPPs and PSPs. Environmental and hydropower issues. The state of small hydropower in Ukraine and its role in the energy balance. The main technical and economic indicators of hydropower.

*Topic 9. Biodiesel and biomass energy.*

Biofuels, types of biofuels. Classification of biomass waste processing methods. Technological schemes of bioethanol production. Biogas production. Use of biomass processing products as a motor fuel - ethyl and methyl alcohols, rapeseed oil. Calculation of economic feasibility of using biodiesel, and methods of commercialization

*Topic 10. Hydrogen economy (energy).*

Methods of hydrogen production. Electrolysis of water. High-Temperature Electrolysis (HTE). Photo-electrochemical splitting of water. Kvarner process. (CB&H) Thermochemical production hydrogen production. Storage and transportation problems. Environmental aspects of hydrogen production.

## DISTRIBUTION BY TYPES OF TRAININGS AND HOURS

Topics	Amount of hours			Individual work	
	All	Classroom work			
		Total	Lectures		Practical
<b>First module. ENERGY AND EFFICIENCY</b>					
<b>Topic 1.</b> Fuel and energy resources of Ukraine.			2		5
<b>Topic 2.</b> Green or Renewable energy in Ukraine .			2	2	5
<b>Topic 3.</b> Strategy for the development of the energy sector in Ukraine and the world.			2		5
<b>Topic 4.</b> Energy consumption and environmental issues.			2	1	5
<b>Topic 5.</b> Energy storage and storage systems.			2	2	10
<i>Amount of hours in first module</i>			<b>10</b>	<b>5</b>	<b>30</b>
<b>Second module. GREEN (RENEWABLE) ENERGY</b>					
<b>Topic 6.</b> Solar energy in Ukraine.			2	1	5
<b>Topic 7.</b> Wind energy in Ukraine.			2	1	5
<b>Topic 8.</b> Hydroelectric power in Ukraine.			2	1	5
<b>Topic 9.</b> Biodiesel and biomass energy.			2	1	10
<b>Topic 10.</b> Hydrogen economy (energy).			2	1	5
<i>Amount of hours in second module</i>			<b>10</b>	<b>5</b>	<b>30</b>

## PRACTICAL WORK

№	Topic	hrs
<b>First module. ENERGY AND EFFICIENCY</b>		
1.	Green or Renewable energy in Ukraine.	2
2.	Energy consumption and environmental issues.	1
3.	Energy storage and storage systems.	2
<b>Second module. GREEN (RENEWABLE) ENERGY</b>		
4.	Solar collectors and photocells. Calculation of efficiency photocell.	1
5.	The optimal mode of operation of the windmill. Calculation of efficiency WPP from wind speed.	1
7.	Bioethanol conversion. Technical indicators. Catalyst selection.	1
8.	Calculation of the specific yield of diesel fuel obtained from rapeseed.	1
9.	Energy calculations of producing hydrogen by three methods: a) electrolysis of steam at high pressure b) electrolysis of water at low pressure c) providing hydrogen in the process of high-temperature electrolysis (HTE)	1

## INDIVIDUAL WORK

№	Topic	hrs
<b>Змістовний модуль 1. ENERGY AND EFFICIENCY</b>		
1.	Fuel and energy resources of Ukraine	5
2.	Green or Renewable energy in Ukraine	5
3.	Strategy for the development of the energy sector in Ukraine and the world	5
4.	Energy consumption and environmental issues	5
5.	Energy storage and storage systems	10
<b>Змістовний модуль 2. GREEN (RENEWABLE) ENERGY</b>		
6.	Solar energy	5
7.	Wind energy	5
8.	Hydroelectric energy	5
9.	Biodiesel and biomass energy	10
10.	Hydrogen economy (energy)	5
	<i>Total:</i>	<b>60</b>



## GRADE SCALING DURING COURSE

Grade scaling during course										Exam	Grade
First module					Second module					100	100
T1	T2	T3	T4	T5	T6	T7	T8	T9	T10		
5	15	5	5	15	10	10	10	15	10		

## ECTS GRADING SCALE

Grading scale	GRADE ECTS	Grade on a national standard	
		Exam	Test
90-100	A	Excellent	To pass
80-89	B	Good	
70-79	C		
65-69	D	Satisfactory	
60-64	E		
35-59	FX	Fail Some more work required before the credit can be awarded	Fail Some more work required before the credit can be awarded
0-34	F	Fail Considerable further work is required	Fail Considerable further work is required

### **EXAMINATION CARD # 1**

1. Fuel and energy resources of Ukraine.
2. Photovoltaic (PV) and solar cells
3. Electrolysis of steam at high pressure.

### **EXAMINATION CARD # 2**

1. Green or Renewable energy in Ukraine.
2. General ESS systems. BESS battery systems. PHS hydraulic accumulators.
3. Electrolysis of water at low pressure.

### **EXAMINATION CARD # 3**

1. Energy efficiency in the industry in the context of sustainable development
2. Principle of operation and classification of wind turbines
3. Obtaining hydrogen in the process of high-temperature electrolysis (HTE)

### **EXAMINATION CARD # 4**

1. Fuel and energy balance of Ukraine.
2. Photovoltaic (PV) or solar cells
3. Electrolysis of steam at high pressure.

### **EXAMINATION CARD # 5**

1. Objectives of the EU and Ukraine in the field of energy resources. Kyoto Protocol.
2. Use of biomass processing products as motor fuel.
3. Photo-electrochemical splitting of water.

### **EXAMINATION CARD # 6**

1. The state of small hydropower in Ukraine and its role in the energy balance.
2. Conversion of bioethanol. Technical indicators. Catalyst selection
3. Calculation of photovoltaic cell efficiency.

### **EXAMINATION CARD # 7**

1. Energy storage and storage systems
2. Calculation of efficiency WPP from the wind speed.
3. Kvarner process (CB&H) of hydrogen production.

## REFERENCES

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2. Управление в энергетике / С. П. Кундас, М.И. Кулик, О.А. Кучинский, Л. Молиторис, К. Павличкова и др.; под ред. д.т.н., профессора С.П. Кундаса //Учебное пособие – Минск: МГЭУ им. А.Д. Сахарова, 2014. – 259 с. - ISBN 978-985-551-093-3
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10. Харченко Н.В. Индивидуальные солнечные установки.- М.: Энергоатомиздат 1991.- 208 с.
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13. Стадницький, Ю. І. Формування біопаливної галузі в Україні: перспективи, проблеми, шляхи оптимізації / Ю. І. Стадницький // Регіон. економіка. – 2008. – №1. – С. 211 – 219.
14. Закон України «Про ринок електричної енергії»
15. Закон України «Про альтернативні джерела енергії»
16. Закон України «Про альтернативні види рідкого та газового палива»
17. Закон України «Про комбіноване виробництво теплової та електричної енергії (когенерацію) та використання скидного енергопотенціалу»
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