MASTER STUDY-PROGRAMME IN INNOVATIVE TECHNOLOGIES FOR ENERGY SAVING AND ENVIRONMENTAL PROTECTION «GREEN MASTER»

DEVELOPED IN THE FRAMEWORK OF
THE TEMPUS PROJECT 530620-TEMPUS-1-2012-1-IT-TEMPUS-JPCR
"LLL TRAINING AND MASTER IN INNOVATIVE TECHNOLOGIES FOR ENERGY SAVING AND ENVIRONMENTAL CONTROL FOR RUSSIAN UNIVERSITIES, INVOLVING STAKEHOLDERS - GREENMA"

PROGRAMME HANDBOOK

in cooperation with

D. Mendeleyev University of Chemical Technology of Russia
Ivanovo State University of Architecture and Civil Engineering
Ivanovo State University of Chemistry and Technology
North Ossetian State University in Vladikavkaz
Perm National Research Polytechnic University
Stavropol State Agrarian University
Tambov State Technical University
Tyumen State University of Architecture and Civil Engineering
Ural Federal University n.a. Boris Eltsin, Yekaterinburg
Vladimir State University n.a. Stoletovs
Voronezh State University of Architecture and Civil Engineering
City University of London, United Kingdom
Silesian University of Technology in Katowice, Poland
Universidad de Alicante, Spain
University of Genova, Italy

TAMBOV STATE TECHNICAL UNIVERSITY
2014

University	**Tambov State Technical University, TSTU, Russia**
Programme level	**Master level**
Status	**Joint International Programme**
Name of the course	**Innovative Technologies for Energy Saving and Environmental Control 280700.04 (Russian education classification code)**
Field and classification code	**Technosphere safety 280700 (Russian education classification code)**
Qualification	**Master of Engineering and Technolofy**
Web-site	**http://greenma.tstu.ru/ http://www.tstu.ru/r.php?r=structure.kafedra&sort=&id=3**
Faculty	**Technological Institute, Institute of Power Engineering**
Address	**TSTU, 112a Michurinskaya Street, 392032 Tambov**
Course length	**2 years**
Workload	**120 credits (in accordance with ECTS and Russian Educational Standard)**
Start date	**September 2014**
Professional recognition	**Stakeholders consulted for the designing of the study-programme:** - **"Tambov Communal Systems" JSC** - **"Tambovvodokanal" JSC** - **"Pigment" JSC** - **"Tambovmash" JSC** - **Institute of Energy Saving of Sverdlovsk Oblast, Yekaterinburg** - **Federal Service on Customers' Rights Protection & Human Well-Being in Vladimir** - **Union of Constructors of Sverdlovsk Region, Yekaterinburg** - **Tambov Regional Administration** - **Energomera JSC in Stavropol**
Teaching organization	**Semester modules, front lectures, field visits, laboratory works, individual work, scientific supervising, Master thesis preparation.**

Preliminary statement:

The process of introducing the two-level education system in the Russian Federation results in changing the workload unit. These measures are settled in order to harmonize the Russian Federation academic systems with the European ones. The term "Russian credit unit" (RCU), in Russian "Zachetnaya edinitsa" ("Passing unit") was introduced for the State Education Standard of the Third generation developed in recent years. One RCU is considered equal to 1 ECTS credit unit. Now the workload of:

Master programme -120 RCU

Bachelor programme -240 RCU

Specialist programme – 300 RCU

According to the methodology suggested by the Russian Ministry of Education:

1 Russian credit unit (RCU) = 36 academic hours

Aims of the programme:
The programme GREEN MASTER proposes a combined approach to the engineering management of energy and sustainability issues. It provides a combination of fundamental issues in engineering management of energy and environmental problems, integrated in the different aspects (energy saving issues, thermodynamic fundamentals, legislation in the field, economic issues, environmental control, optimization models).
The master programme aims to give graduate students an in-depth knowledge of energy and resource fundamentals, natural resource management, complex approach to innovations, monitoring techniques and environmental control of emissions and work environment for evaluating real environmental conditions and preserving environmental heritage. The Green Master will be an expert in renewable energy and energy management, environmental monitoring to work in firms and public bodies capable to solve safety, environment and quality problems.

The study-programme will develop the following competences (or generic skills):

The Green Master will obtain complex skills in design, operation and management with the focus on system and process engineering related to the production of main energy areas: electricity, heat, fuel.
The programme graduates will acquire proper skill in conceptual design of energy conversion processes and their components. They will be able to evaluate and solve main engineering problems (thermal, environmental, mechanical, chemical, electrical) which may occur in the modern energy conversion systems.
The Master after the completion of the programme will be able to analyse and assess operational and maintenance properties of energy systems, to use renewable energy sources and non-conventional technologies.

Programme languages: Russian and English

Admission criteria:

- **Bachelor or Specialist degree** in a relevant branch of Science or Engineering, with specific reference to Industrial Chemistry, Chemical Engineering, Civil Engineering, Energy Saving, Nature Management and Environment Protection; work experience in above fields is appreciated.
- **English language** (to be assessed by an interview).
- **Foreign** candidates are required to have the certificate of Russian language course attendance.

Teaching methods
Teaching will be organized according to three main principles

- strong interdisciplinary approach
- problem solving approach for synthesis between the different subjects
- modeling instruments for process analysis

The outcome of this approach will be professional ability to apply and share expertise with the team of energy technology and environmental control
The teaching process will consist of seminars, research supervision, practices, creative workshops, problem solution classes, laboratory classes, internships, mobilities, field practice, e-learning.

The peculiar feature of the programme is introducing the **latest international education** achievements into it, with specific reference to:

1. Tuning methodology
2. Dublin descriptors
3. ECTS

In accordance with the "Dublin Descriptors", Qualifications that signify completion of the second cycle are awarded to students who have completed a programme of study that enables them to show:

- knowledge and comprehension that is founded upon, extends and enhances that associated with the Bachelor's level and is at the forefront of a field of learning;
- a critical awareness of current problems and new insights, new tools and new processes within their field of learning, or the development of professional skills;
- that they can apply their knowledge and comprehension, their critical awareness and problem solving abilities, within the context of research, or in the development of professional skills, in broader or multidisciplinary areas related to their fields of study;
- that they have the ability to integrate knowledge and handle complexity, to formulate judgements with incomplete or limited information, either individually or in groups, which includes (where relevant) reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements;
- that they can lead or initiate activity, and take responsibility for the intellectual activities of individuals or groups;
- that they can communicate their conclusions, and knowledge, rationale and processes underpinning these, to specialist and non-specialist audiences clearly and unambiguously;
- that they possess the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

Programme structure

Basic subjects

- Theory of energy efficiency for technosphere safety

Compulsory subjects

- "Green technologies" of sustainable development
- Improvement of energy efficiency in natural and industrial systems
- Energy and environment audit. (*Divided in 2 parts: Energy and environment audit of industrial objects. Legal aspects.)*
- Fundamentals of thermodynamics and exergy analysis
- Modeling of technological and natural systems. *(Mathematical modeling of energy efficiency projects)*
- Lyfe cycle of energy, energy management and optimal decision making
- Environmental safety and energy sustainable development

Elective subjects

- Practical application of green technologies (case studies) */Development of highly efficient and environmentally safe energy systems*
- Fundamentals of thermodynamics and exergy analysis. *Development of economically effective and environmentally safe power stations.*
- Environmental control and modelling of energy efficient projects. *Laboratory environmental control*
- Energy and environmental audit. *Theory of Measuring Experiment.*
- Engineering and economic analysis of energy saving activity. *Efficient use of traditional and renewable sources of energy*
- Engineering and economic analysis of energy saving activity. *Perspective use of different types of primary energy resources for heat and electrical power generation.*
- Conventional and renewable energy sources/Advanced usage of different kinds of energy sources for heat and electric power
- Business English/History and significance of Bologna Process for higher education development

Practical Research
Master Thesis

Name of the module	Credit points (per semester)	Type of assessment[i] in current semester	Teachers
SEMESTER 1			
Theory of energy efficiency for technosphere safety *(basic block)*	12	examination, written paper	Prof. Nikolay Popov, doctor of science
Improvement of energy efficiency in natural and industrial systems	1,5	test	Prof. Nikolay Popov, doctor of science
English Language for Environmental Studies	*3*	*examination*	Ass. Prof. Natalia Gunina, candidate of science
History and significance of Bologna Process for higher education development	*3*	*examination*	Head of Intern. Office Lilia Mozerova
Scientific and research work in semester	7,5	test	
	24		
SEMESTER 2			
Theory of energy efficiency for technosphere safety *(basic block)*	3	test	Prof. Nikolay Popov, doctor of science
Improvement of energy efficiency in natural and industrial systems	2,5	*examination*	Prof. Nikolay Popov, doctor of science
Energy and environmental audit. *Energy and environmental audit of industrial objects. Legal aspects.*	5	test	Ass. Prof. Artemiy Kozachek, candidate of science
Fundamentals of thermodynamics and method of exergy analysis	4	written paper, examination	Prof. Vasily Lyashkov, candidate of science
Environmental safety and energy sustainable development	3	test	Prof. Nikolay Popov, doctor of science
Engineering and economic analysis of energy saving activity. *Conventional and renewable energy sources*	*6*	*examination*	Ass. Prof. Alexander Kobelev, candidate of science
Engineering and economic analysis of energy saving activity. *Advanced usage of different kinds of energy sources for heat and electric power.*	*6*	*examination*	Oleg Milovanov, PhD student
Scientific and research work in semester	8	test	
Scientific and research practice	4,5	test	
	36		

SEMESTER 3			
Theory of energy efficiency for technosphere safety *(basic block)*	2	test	Prof. Nikolay Popov, doctor of science
"Green technologies" of sustainable development	3	examination	Ass.Prof. Irina Yakunina, candidate of science
Modeling of technological and natural systems. *(Mathematical modeling of energy efficiency projects)*	2	test	Ass. Prof.Ilya Tyurin, candidate of science
Lyfe cycle of energy, energy management and optimal decision making. *Energy management and optimal decision making*	2	test	Ass.Prof. Sergey Kochergin, candidate of science
"Green technologies" of sustainable development *"Green technologies" application in industrial systems design*	*4*	*examination*	Olga Peshcherova, PhD student
Fundamentals of thermodynamics and exergy analysis *Development of highly efficient and environmentally safe energy systems*	*4*	*examination*	Ass. Prof. Alexey Balashov, candidate of science
Environmental control and modelling of energy efficient projects. *Laboratory environmental control.*	*5*	*examination*	Ass.Prof. Irina Yakunina, candidate of science
Energy and environmental audit. *Theory of Measuring Experiment.*	*5*	*examination*	Prof. Tatyana Chernyshova, doctor of science
Scientific and research work in semester	6	test	
	24		
SEMESTER 4			
Scientific and research practice	6	ЗО	
Final State Examination	30		
	36		

Programme Outcomes

A. Knowledge and understanding	Teaching/learning methods
1. Gain knowledge of energy sources, energy generation peculiarities and transfer 2. Understand methods of system approach to analysis and synthesis of energy consumption processes 3. Consider methods of technical and economical analysis of energy consumption processes 4. Understand methods of optimal decisions search 5. Acquire in-depth knowledge of energy and eco audit technology 6. Understand limit thermo-dynamic systems of energy consumption 7. Understand necessity of complex study of research objects 8. Gain knowledge of energy saving systems and equipment	Students gain knowledge and understanding through attendance in lectures, seminars and laboratories. Besides a variety of learning activities is conducted, such as: group projects, case study analysis, field trips, student presentations. Electronic resources will be used to enhance student learning experiences. Students will be directed to explore a wide range of various learning materials, such as books, journals, patents, as well as electronic sources and web links. **Assessment method** Students' knowledge and understanding is assessed by a variety of methods such as examinations, tests, laboratory reports, case study analysis and student presentations

B. Practical skills	Teaching/learning methods
1. Be able to inspect energy consumption systems to improve their energy efficiency and ecological safety 2. Use tools of power economy and industrial ecology diagnostics 3. Conduct energy and exergy balances of research objects 4. Choose criteria for solution assessment in ecological and power systems 5. Organize creative teamwork for complex inspection of industrial processes 6. Develop work plans in energy saving 7. Assess chosen scientific approaches to objectives solution 8. Analyse potential energy saving opportunities 9. Assess environmental consequences of energy saving activities	Students learn cognitive skills through attendance in seminars and laboratories, doing group and mini group projects, case study analysis, field trips, student presentations. Electronic resources will also be used to enhance student cognitive skills. **Assessment method** Students' cognitive skills are assessed by a variety of methods such as examinations, tests, laboratory reports, case study analysis and presentations. A specific accent in the assessment is made on the ability of a student to critically classify, asses, debate, interpret and operate.

C. Graduate skills	Teaching/learning methods
1 Develop critical thinking and carry out research (e.g. Present critically and compare their own views and those that differ from their own in native language and in English). 2 Identify and use various learning sources in students' scientific occupations. 3 Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written and electronic modes of communication (in native language and in English). 4 Make informed professional decisions based on scientific knowledge and appropriate criteria. 5 Work effectively individually or in groups to accomplish assigned tasks. 6 Develop efficient time management skills. 7 Appreciate the social impact of research and practical work in the field of study 8 Reflect and evaluate on own learning and evaluate peers in a professional manner.	Students acquire graduate skills through participation in seminars and laboratories, doing group and mini group projects, case study analysis, field trips, student presentations, completion of dissertation module, attendance on specific modules. Electronic resources will also be used to enhance student cognitive skills. **Assessment method** Students' graduation skills are assessed by dissertation module, laboratory reports, essays, group project and data analysis assessment

Module 1

Module title	**«Green Technologies» of Sustainable Development**
Course title	1. "Green Technologies" of Sustainable Development 2. Application practice of "green technologies" in industrial systems design
Credits	1. 3 credits, 108 academic hours 2. 4 credits, 144 academic hours
Module leader and assistant (if any)	1. Associate Professor Irina Yakunina, candidate of chemical sciences, PhD, chair "Nature Management and Environment Protection". 2. Assistant Olga Peshcherova, chair "Nature Management and Environment Protection", post-graduate student.
Study terms	1. 2nd year, 3d semester 2. 2nd year, 3d semester

Aim of the module

Brand new technological decisions are needed to realize the strategies of ecologically oriented economical development of the country. These, above all include "green technologies" (environmentally friendly) aiming at decrease of negative effect on environment by means of decreasing wastes, reduction of resources consumption, substitution of toxic and dangerous materials by non-toxic and low-hazard ones, etc.

Including this module into the master programme let teaching the methods of general environmental wastes management, land recreation, prevention of air, water and soil pollution by means of ecodesign. This module makes possible to introduce to the students examples of renewable energy production (wind and sun energy, bio fuel, etc.), rise of traditional fuel efficiency, improvement of energy consumption systems in buildings and constructions, residential spheres and other trends of human household activity.

The study of materials of the present module allows the master students to acquire new knowledge in the field of ecodesign and to be ready to take part in fundamental transformation of global economics.

Lectures	1.18 hours
Practical studies	1. 18 hours
Individual work	1. 36 hours 2. 72 hours

Learning outcomes

Knowledge and understanding:

- Gain knowledge of energy sources, energy generation peculiarities and transfer
- Consider methods of technical and economical analysis of energy consumption processes
- Understand methods of optimal decisions search
- Understand limit thermo-dynamic systems of energy consumption
- Understand necessity of complex study of research objects
- Gain in-depth knowledge of strategic policies of Russia in environmental and economic development sphere

- Understand significance of innovation technologies for power economy modernization in the country
- Acquire knowledge of control means for natural environments quality
- Study “Green technologies” opportunities
- Gain knowledge in technological regulations

Practical skills

- Be able to inspect energy consumption systems to improve their energy efficiency and ecological safety
- Choose criteria for solution assessment in ecological and power systems
- Organize creative teamwork for complex inspection of industrial processes
- Develop work plans in energy saving
- Assess chosen scientific approaches to objectives solution
- Assess environmental consequences of energy saving activities
- Evaluate environmental risks
- Calculate energy and material balances
- Evaluate energy consumption level in correspondence to regulations
- Choose “green technologies” to improve energy efficiency in industrial systems

Graduate (or Transferable) skills

- Develop critical thinking and carry out research (e.g. Present critically and compare their own views and those that differ from their own in native language and in English).
- Identify and use various learning sources in students’ scientific occupations.
- Work effectively individually or in groups to accomplish assigned tasks.
- Appreciate the social impact of research and practical work in the field of study

Assessment methods

Student presentations, practice report, questionnaire, exam, case study analysis

Module 2

Module title	**Improvement of Energy Efficiency in Natural and Industrial Systems**
Course title	Improvement of Energy Efficiency in Natural and Industrial Systems
Credits	4 credits, 144 academic hours
Module leader and assistant (if any)	Prof. Nikolay Popov, PhD, Doctor of Technical Sciences, Head of the Chair "Nature Management and Environment Protection"
Study terms	1st year, 1-2 semesters

Aim of the module

This module depicts objective demands of the countries in different energy sources. They are connected with population growth, agricultural and industrial development, residential infrastructure creation, etc. At the basis of these processes EU and Russia realize energy saving strategies.

Master students acquire knowledge of the global problems of energy generation, transportation and use in different spheres of human activity; realize the necessity of "green technologies" application to increase energy efficiency of natural and industrial systems (NIS).
The present module shows specificity of NIS as microsystems with stochastic character. Set-theoretical formalization is given, general NIS model is schemed. Master students face the problems of sustainable energy and environment management of NIS in regular and special situations, examples are given. They gain the knowledge of a single scientific approach to solve the problems of the study programme.

Lectures **1st semester**	18 hours
Practical studies **2nd semester**	18 hours
Individual work **1st semester** **2nd semester**	 36 hours 36 hours

Learning outcomes

Knowledge and understanding:

- Understand methods of system approach to analysis and synthesis of energy consumption processes
- Consider methods of technical and economical analysis of energy consumption processes
- Understand limit thermo-dynamic systems of energy consumption
- Understand necessity of complex study of research objects
- Gain knowledge of energy saving systems and equipment
- Understand features of environmental and industrial objects interrelation
- Acquire knowledge of quality indicators of natural and industrial systems (NIS)
- Understand methods of system approach to analysis and synthesis of energy consumption processes

- Study features of NIS mathematical description
- Understand connection of chemical reactor and ecological reactor theories

Practical skills

- Be able to inspect energy consumption systems to improve their energy efficiency and ecological safety
- Choose criteria for solution assessment in ecological and power systems
- Organize creative teamwork for complex inspection of industrial processes
- Develop work plans in energy saving
- Formalize NIS management aims
- Evaluate criteria for macrosystems
- Develop structural schemes for natural and industrial subsystems interaction
- Define energy consumption standards
- Use technical means to control environment safety and power losses

Graduate (or Transferable) skills

- Develop critical thinking and carry out research (e.g. Present critically and compare their own views and those that differ from their own in native language and in English).
- Identify and use various learning sources in students' scientific occupations.
- Make informed professional decisions based on scientific knowledge and appropriate criteria.
- Work effectively individually or in groups to accomplish assigned tasks.
- Develop efficient time management skills.
- Reflect and evaluate on own learning and evaluate peers in a professional manner.

Assessment methods

Interview, tests, exam, student presentations, business plan, bibliographic references review

Module 3

Module title	**Energy Life Cycle, Energy Management and Optimal Decisions Making**
Course title	Energy Management and Optimal Decisions Making
Credits	2 credits, 72 academic hours
Module leader and assistant (if any)	Ass. Prof. Sergey Kochergin, Phd, chair "Power industry"
Semester	2nd year, 3rd semester

Aim of the module

In the framework of the present module master students study the problems of energy management. 3 general aspects are considered: decrease of energy consumption by restriction, management, social and economic influence; efficiency rise due to improvement of the processes and operation, more efficient use of equipment; replacement of energy sources for those with more rational results of consumption. Energy use management programme considers the whole energy life cycle (generation, consumption and distribution).

Decisions in the sphere of energy efficiency are made with the help of certain optimization methods. In the process of study master students use packages of programmes with one- and many-dimensional methods of extremum search, use different criteria of energy efficiency of engineering processes and equipment.

Master students study energy saving methods in different engineering processes, apply their knowledge by writing course projects and master thesis.

Practical studies	36 hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- Gain knowledge of energy sources, energy generation peculiarities and transfer
- Understand methods of system approach to analysis and synthesis of energy consumption processes
- Consider methods of technical and economical analysis of energy consumption processes
- Understand methods of optimal decisions search
- Understand necessity of complex study of research objects
- Gain knowledge of energy saving systems and equipment
- Acquire knowledge of regulative and reference documentation in energy saving sphere
- Study engineering regulations of industrial processes
- Understand methods of system approach to analysis and synthesis of energy consumption processes
- Acquire in-depth knowledge of life cycle of energy in particular NIS

Practical skills

- Be able to inspect energy consumption systems to improve their energy efficiency and ecological safety
- Use tools of power economy and industrial ecology diagnostics
- Choose criteria for solution assessment in ecological and power systems

- Organize creative teamwork for complex inspection of industrial processes
- Develop work plans in energy saving
- Analyse potential energy saving opportunities
- Define weak points of industrial power economy
- Develop recommendations in energy efficiency improvement of engineering processes
- Choose energy saving control and management systems at enterprise and efficient equipment and control system
- Use properly computer programmes

Graduate (or Transferable) skills

- Develop critical thinking and carry out research (e.g. Present critically and compare their own views and those that differ from their own in native language and in English).
- Identify and use various learning sources in students' scientific occupations.
- Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written and electronic modes of communication (in native language and in English).
- Make informed professional decisions based on scientific knowledge and appropriate criteria.
- Work effectively individually or in groups to accomplish assigned tasks.
- Appreciate the social impact of research and practical work in the field of study

Assessment methods

Abstracts, tests, student presentations, practice report, questionnaire.

Module 4

Module title	**Energy and Environment Audit**
Course title	1. Energy and Environment Audit of Industrial Objects 2. Theory of Measuring Experiment
Credits	1. 5 credits, 180 academic hours 2. 5 credits, 180 academic hours
Module leader and assistant (if any)	1. Associate Professor Artemiy Kozachek, Candidate of Pedagogical Sciences, Chair "Nature Management and Environment Protection" 2. Prof. Tatyana Chernyshova, PhD, doctor of technical sciences, chair "Design of Radio-electronic and Microprocessor Systems"
Study terms	1. 1st year, 2nd semester 2. 2nd year, 3rd semester

Aim of the module

The aim of this module is the necessity to introduce to the master students methods of energy resources revision and loss reduction in every system of energy supply with simultaneous environmental control. Traditional energy audit, described in the present module, includes technical investigation, analysis of energy generation and consumption systems efficiency to minimize energy resources consumption. Environmental audit methods are shown in the frames of investment projects and energy saving programmes establishment.

In the process of study of the present module master student acquires knowledge in the sphere of energy and environment audit, as well as skills to work with tools for energy and environment processes control.

Much attention is paid to a new method of joint energy and environment audit aimed at simultaneous understanding of industrial modernization problems in terms of power engineering and environment.

Practical studies	1. 36 hours 2. 36 hours
Individual work	1.108 hours 2. 90 hours
Laboratory work	1. 0 2. 18 hours

Learning outcomes

Knowledge and understanding:

- Understand methods of system approach to analysis and synthesis of energy consumption processes
- Consider methods of technical and economical analysis of energy consumption processes
- Acquire in-depth knowledge of energy and eco audit technology
- Gain knowledge of energy saving systems and equipment
- Acquire knowledge of methods of systematic inspection of industries for energy efficiency and environment safety

- Understand energy and ecology audit organizational order
- Gain knowledge of audit tools
- Gain knowledge of regulative indexes of energy consumption
- Understand technologies of energy saving in branches
- Consider methods of technical and economical analysis of energy consumption processes

Practical skills

- Be able to inspect energy consumption systems to improve their energy efficiency and ecological safety
- Use tools of power economy and industrial ecology diagnostics
- Choose criteria for solution assessment in ecological and power systems
- Develop work plans in energy saving
- Analyse potential energy saving opportunities
- Organize energy and ecology audit
- Use properly the audit tools
- Use appropriate software
- Make audit reporting

Graduate (or Transferable) skills

- Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written and electronic modes of communication (in native language and in English).
- Make informed professional decisions based on scientific knowledge and appropriate criteria.
- Develop efficient time management skills.
- Appreciate the social impact of research and practical work in the field of study
- Reflect and evaluate on own learning and evaluate peers in a professional manner.

Assessment methods

Exam, practice report, laboratory report, defence of laboratory report, student presentations, audit plan.

Module 5

Module title	**Fundamentals of Thermodynamics and Exergy Analysis**
Course title	1. Fundamentals of Thermodynamics and Exergy Analysis 2. Development of Highly Efficient and Environmentally Friendly Power Plants
Credits	1. 4 credits, 144 academic hours 2. 4 credits, 144 academic hours
Module leader and assistant (if any)	1. Prof. Vasily Lyashkov, PhD, Chair "Enterprise Energy Supply and Heat Engineering" 2. Ass. prof. Aleksey Balashov, PhD, Chair "Enterprise Energy Supply and Heat Engineering"
Study terms	1. 1st year, 2nd semester 2. 2nd year, 3rd semester

Aim of the module

To study and to design new life support systems is possible only at the bases of thermodynamic laws regulating these systems. The present module deals with the history of thermodynamic analysis and its opportunities in power systems design and operation. The aims of thermodynamic systems are: functional relations between components of natural and industrial systems; value of mass flows and properties of operational liquids in different parts of the system; levels of energy, exergy and irreversibility; fuel and other resources consumption; interrelations between technical qualities of compounds (pipes diameter, heat transfer square, engine power) and operational parameters (temperature, pressure, velocity, flows value, energy transfer, level of exergy and its annihilation, etc.); loss of energy and exergy, exergy annihilation, point where these processes take place and reasons (that help to minimize or to recover them); efficiency of single compounds or the whole system (this knowledge is necessary for evaluation of system productivity and comparison to other systems); harmful impacts of the system on environment (e.g. heat or chemical pollution).

Master students study thermodynamic analysis method, its link with economic indexes of the quality of different engineering systems, which help to compare various variants of energy efficiency solutions. Exergy is used as universal quality measure. The students master exergy method of thermodynamic analysis, compose systems exergic balances, view technical and economical supplements of exergy.

Generally, module materials help the students to develop mathematical models of energy consuming systems and pay their attention to project decisions optimization.

Lectures	1. 18 hours 2. 0
Laboratory works	1. 18 hours 2. 0
Practical studies	1. 18 hours 2. 36 hours
Individual work	1. 54 hours 2. 72 hours

Learning outcomes

Knowledge and understanding:

- Gain knowledge of energy sources, energy generation peculiarities and transfer
- Understand methods of system approach to analysis and synthesis of energy consumption processes
- Understand limit thermo-dynamic systems of energy consumption
- Understand necessity of complex study of research objects
- Gain knowledge of energy saving systems and equipment
- Acquire in-depth knowledge of thermodynamic laws
- Understand energy balances in energy consumption systems analysis
- Understand exergy analysis significance
- Study opportunities of exergy balances and their graphical expression
- Gain knowledge of energy sources, energy generation peculiarities and transfer

Practical skills

- Conduct energy and exergy balances of research objects
- Assess chosen scientific approaches to objectives solution
- Analyse structurally engineering systems
- Conduct energy and exergy balances
- Evaluate energy efficiency of certain process units and entire technology
- Define exergy loss
- Evaluate energy life cycle in engineering system

Graduate (or Transferable) skills

- Develop critical thinking and carry out research (e.g. Present critically and compare their own views and those that differ from their own in native language and in English).
- Identify and use various learning sources in students' scientific occupations.
- Work effectively individually or in groups to accomplish assigned tasks.

Assessment methods

Exam, course works, laboratory reports, practical tasks fulfilment, tests.

Module 6

Module title	**Engineering and Economic Analysis of Energy Saving Activity**
Course title	1. Efficient use of traditional and renewable sources of energy 2. Perspective use of different types of primary energy resources for heat and electrical power generation
Credits	1. 6 credits, 216 academic hours 2. 6 credits, 216 academic hours
Module leader and assistant (if any)	1. Ass. prof. Alexander Kobelev, PhD, Chair "Power Engineering" 2. PhD student Oleg Milovanov, Chair "Enterprise Energy Supply and Heat Engineering"
Study terms	1. 1st year, 2nd semester 2. 1st year, 2nd semester

Aim of the module

The aim of this module is to study the heat economics opportunities while projecting and operating an energy system.. Thermoeconomics means joint application of two disciplines (thermodynamics and economics) for analysis, improvement and optimization of technological production. In the process of the module study master students understand the essence of economic analysis of energy processes, based on either monetary or exergic value. Latter means "exergic and economic analysis".

Aims of energy saving oriented thermodynamics:

- to determine distribution of system construction and operation costs (as well as inner system costs);
- to decrease energy loss by changing the processes of projecting (ecodesign) or operation;
- to optimize system structure and operational regimes;
- to evaluate system productivity and to compare its properties with alternatives;
- to make decisions over equipment operation and renovation;
- to help to distribute the project budget for research, development and distribution of energy efficient technologies.

In the course of the module master students study criteria for evaluation of technologies energy efficiency, gain the skills to chose target functions of exergic thermodynamic optimization and learn calculation examples for costs distribution between products in complex productions.

Practical studies	1. 36 hours 2. 36 hours
Individual work	1. 126 hours 2. 126 hours

Learning outcomes

Knowledge and understanding:

- Gain knowledge of energy sources, energy generation peculiarities and transfer
- Understand methods of system approach to analysis and synthesis of energy consumption processes

- Consider methods of technical and economical analysis of energy consumption processes
- Understand methods of optimal decisions search
- Gain knowledge of principles of industrial organization and functioning
- Acquire knowledge of methods of productions economic efficiency calculation
- Understand SWOT – analysis of enterprises activity
- Understand economical risks of enterprises

Practical skills

- Choose criteria for solution assessment in ecological and power systems
- Develop work plans in energy saving
- Analyse potential energy saving opportunities
- Assess environmental consequences of energy saving activities
- Set evaluation criteria choice for energy efficiency of engineering processes
- Evaluate economic losses after the use of inefficient equipment
- Evaluate innovation solutions costs in power economy modernization
- Evaluate investment risks evaluation

Graduate (or Transferable) skills

- Develop critical thinking and carry out research (e.g. Present critically and compare their own views and those that differ from their own in native language and in English).
- Identify and use various learning sources in students' scientific occupations.
- Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written and electronic modes of communication (in native language and in English).
- Make informed professional decisions based on scientific knowledge and appropriate criteria.
- Work effectively individually or in groups to accomplish assigned tasks.
- Appreciate the social impact of research and practical work in the field of study

Assessment methods

Exam, practice reports, student presentations, using information technologies.

Module 7

Module title	**Environmental Control and Modeling of Energy Efficient Projects**
Course title	Laboratory Environmental Control
Module leader and assistant (if any)	Associate Professor Irina Yakunina, candidate of chemical sciences, PhD, chair "Nature Management and Environment Protection"
Study terms	2nd year, 3rd semester

Aim of the module The aim of this module is to teach the master students present regulations of environmental law as a part of planning and production. The content of the module includes the problems of negative influence of energy consuming technologies on environment quality, morbidity and biodiversity reduction. The problems of equipment updating, fuel systems replacement, energy losses reduction, choice of equipment operational regimes are viewed in the framework of environmental law regulations. Including environmental component into economical processes of production carries a theoretical character.

Master students study the methods of natural environments quality control (water, air, soil). They master the technique of experiment and data processing, pollution consequences forecast and damage evaluation.

Laboratory work	18 hours
Practical studies	36 hours
Individual work	90 hours

Learning outcomes

Knowledge and understanding:

- Understand methods of system approach to analysis and synthesis of energy consumption processes
- Understand methods of optimal decisions search
- Understand necessity of complex study of research objects
-
- Understand ecomonitoring purpose
- Gain knowledge of opportunities and methods of mathematical modeling
- Gain knowledge of methods of problem numerical solutions
- Study opportunity to use expert systems

Practical skills

- Use tools of power economy and industrial ecology diagnostics
- Conduct energy and exergy balances of research objects
- Assess chosen scientific approaches to objectives solution
- Analyse potential energy saving opportunities
- Assess environmental consequences of energy saving activities
- Set tasks for energy saving problem solution.
- Apply environmental control instruments
- Develop models for admixtures transfer to environment
- Design technology and equipment operation models

Graduate (or Transferable) skills

- Identify and use various learning sources in students' scientific occupations.
- Communicate and negotiate effectively with different stakeholders individually and in-

group using verbal, written and electronic modes of communication (in native language and in English).

- Make informed professional decisions based on scientific knowledge and appropriate criteria.
- Develop efficient time management skills.
- Reflect and evaluate on own learning and evaluate peers in a professional manner.

Assessment methods

Laboratory reports, practice report, exam, questionnaire.

Module 8

Module title	**Modeling of Technological and Natural Systems**
Course title	Mathematical Modeling of Energy Efficient Projects
Credits	2 credits, 72 academic hours
Module leader and assistant (if any)	Associate Professor Ilya Tyurin, PhD, chair "Design of Radio-electronic and Microprocessor Systems"
Study terms	2nd year, 3rd semester

Aim of the module

The aim of the present module is to teach master students methods of mathematical modeling of industrial environment systems, their application in optimization of energy efficient and environmentally friendly solutions. In the module structure different mathematical model classes are viewed- determined and probabilistic, linear and non-linear, one- and many-dimensional, stationary and non- stationary. Basing on system analysis principles, material and energy balances, chemistry and thermodynamics laws master students learn how to formulate models demands and later to design them. Apart from this they study numerical methods of model equations solutions (Euler, Runge-Kutta, etc.). Possessing the skill to design mathematical models of technological and environment processes master students can formulate optimization problems for energy effective projects.

Laboratory work	18 hours
Practical studies	18 hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- Understand methods of system approach to analysis and synthesis of energy consumption processes
- Consider methods of technical and economical analysis of energy consumption processes
- Understand methods of optimal decisions search
- Understand necessity of complex study of research objects
- Understand problems of energy saving and environment safety
- Acquire knowledge of system approach to design processes models
- Know algorithm operations

Practical skills

- Choose criteria for solution assessment in ecological and power systems
- Organize creative teamwork for complex inspection of industrial processes
- Assess environmental consequences of energy saving activities
- Set tasks of energy consumption optimization problem
- Conduct nature research at the objects
- Design mathematical models
- Check model conformity with the stated problem
- Apply for a patent

Graduate (or Transferable) skills

- Identify and use various learning sources in students' scientific occupations.
- Make informed professional decisions based on scientific knowledge and appropriate criteria.
- Develop efficient time management skills.

Assessment methods
Laboratory and practice reports, test, information technologies and software using.

Module 9

Module title	**Environmental Safety and Energy Sustainable Development**
Course title	Environmental Safety and Energy Sustainable Development
Credits	3 credits, 108 academic hours
Module leader and assistant (if any)	Prof. Nikolay Popov, PhD, Doctor of Technical Sciences, Head of the Chair "Nature Management and Environment Protection"
Study terms	1st year, 2rd semester

Aim of the module

The aim of the present module is to master theoretical knowledge while studying exact examples of how to search for optimal projects solutions which can improve the quality of natural and industrial systems operation. These include pumping stations, heat supply stations, water treatment systems, rubber compound production, ventilation systems, cooling plants, etc. The most important component of the module is integration of all previously viewed scientific approaches and disciplines in a whole- interdisciplinary problem of energy saving and environment safety.

Practical studies	18 hours
Individual work	90 hours

Learning outcomes

Knowledge and understanding:

- Gain knowledge of energy sources, energy generation peculiarities and transfer
- Understand methods of optimal decisions search
- Acquire in-depth knowledge of energy and eco audit technology
- Gain knowledge of energy saving systems and equipment
- Critical understanding of energy saving problems at enterprises
- Understand "green" technologies introduction
- "Gain knowledge of "know how" in energy efficiency solutions

Practical skills

- Be able to inspect energy consumption systems to improve their energy efficiency and ecological safety
- Use tools of power economy and industrial ecology diagnostics
- Develop work plans in energy saving
- Analyse potential energy saving opportunities
- Search for analogues of efficient energy consumption world wide
- Analyse technologies in the frames of sustainable development strategy
- Apply interdisciplinary approach to problem solving

Graduate (or Transferable) skills

- Develop critical thinking and carry out research (e.g. Present critically and compare their own views and those that differ from their own in native language and in English).
- Identify and use various learning sources in students' scientific occupations.
- Make informed professional decisions based on scientific knowledge and appropriate criteria.
- Work effectively individually or in groups to accomplish assigned tasks.
- Develop efficient time management skills.

Assessment methods
Test, practice reports, abstracts, students presentations.

Module 10

Course title	**1. English Language for Environmental Studies** **2. History and significance of Bologna Process for higher education development**
Credits	3 credits, 108 academic hours
Module leader and assistant (if any)	Ass. prof. Natalya Gunina, PhD, Head of the Chair "International Professional and Scientific Communication"
Study terms	1. 1st year, 1st semester 2. 1st year, 1st semester

Aim of the module

This module is aimed at intensive teaching of the English language to the students, for whom English is the second or additional language. This intensive programme can help students to build their English language skills for success in university, research or career and in environmental carrier in particular.
The program emphasizes highly effective academic communication skills by focusing on four skill areas – reading, writing, speaking and listening, as well as academic study skills. The teaching process comprises communicative activities, practical exercises, group work, presentations and assignments.
The history and significance of the Bologna Process will be presented in the context of European Higher Education Area development.

Practical studies	1. 36 hours 2. 36 hours
Individual work	1. 36 hours 2. 36 hours

Learning outcomes

Knowledge and understanding:

- Gain Knowledge of main events of the Bologna process
- Understand significance of BP application

Skills and competences

- demonstrate the confidence and listening/speaking skills necessary to participate successfully in spontaneous oral exchanges with native speakers of English in a variety of personal, professional, and/or academic settings;
- demonstrate reading comprehension of English texts intended for developmental (or higher level) English courses.
- respond appropriately to written or spoken English by writing paragraphs or short essays that communicate ideas clearly.

Graduate (or Transferable) skills

- make professional presentations in English
- communicate and negotiate effectively in English with different stakeholders.
- use language to think and reason, as well as to access, process and use information for learning.

Assessment methods

Abstract, exam, presentations

Module 11

Course title	**Theory of energy efficiency for technosphere safety**
Credits	17 credits, 612 academic hours
Module leader and assistant (if any)	Prof. Nikolay Popov, PhD, Doctor of Technical Sciences, Head of the Chair "Nature Management and Environment Protection"
Study terms	1st year and 2nd year, 1-3 semesters

Aim of the module

Aim of the module is to develop skills of creative approach in professional problems solutions under conditions of intensive introduction of modern methods and devices in the sphere of industrial safety expertise, safety monitoring in the frames of energy analysis, as well as skills of economic evaluation of introduced technologies in NIS efficiency improvement with the use of modern information technologies.

Lectures	**Lectures**
Practical studies	**Practical studies**
Laboratory work	**Laboratory work**
Individual work	**Individual work**

Learning outcomes

Knowledge and understanding:

- Gain knowledge of energy sources, energy generation peculiarities and transfer
- Understand methods of system approach to analysis and synthesis of energy consumption processes
- Consider methods of technical and economical analysis of energy consumption processes
- Understand limit thermo-dynamic systems of energy consumption
- Gain knowledge of energy saving systems and equipment
- Understand limit thermo-dynamic systems of energy consumption
- Conduct energy and exergy balances of research objects
- Choose criteria for solution assessment in ecological and power systems
- Assess environmental consequences of energy saving activities

Practical skills

- Conduct energy and exergy balances of research objects
- Choose criteria for solution assessment in ecological and power systems
- Assess chosen scientific approaches to objectives solution
- Assess environmental consequences of energy saving activities
- Forecast, define the areas of technogenic risks
- Optimize the methods and means of power safety maintenance
- Develop recommendations in improvement of NIS energy efficiency level
- Make economical assessment of introduced engineering activities efficiency

Graduate (or Transferable) skills

- Develop critical thinking and carry out research (e.g. Present critically and compare their own views and those that differ from their own in native language and in English).
- Identify and use various learning sources in students' scientific occupations.
- Appreciate the social impact of research and practical work in the field of study

Assessment methods
Test, exam, laboratory and practice reports, student presentations.

Module 12

Course title	**1. Scientific and Research Work in Semester** **2. Scientific and Research Practice**
Credits	1. 21,5 credits, 774 academic hours 2. 10,5 credits, 378 academic hours
Module leader and assistant (if any)	all teachers of the programme- scientific supervisors of the master students
Study terms	1. 1st year and 2nd year, 1-3 semesters 2. 21st year and 2nd year, 2 and 4 semesters

Aim of the module

Aims of scientific and research work of master students:

1. Study of industrial object (topic) in the frames of energy and environment efficiency
2. Statement of research problems
3. Research of mathematical methods and algorithms of optimal solutions search in energy saving and environment protection
4. Substantiation of technology and equipment choice, favouring practical realization of the problems determined in p.2

Aims of scientific and research practice of master students:

1. Knowledge of processes of industrial energy consumption
2. Detection of defects in energy and environment control
3. Choice of objects for scientific research in energy saving sphere

Learning outcomes

Practical skills

The skill to conduct projects and tasks, defined by leading organization in the process of study. Skills to conduct research, based on experimental works, accurately, proving validity of results. Skills to review the data, define cause-effect relations, innovation and relative characteristics of research

Assessment methods

Research and practice reports, information technologies and software using.

Module 13

Course title	**Master Thesis**
Credits	30 credits, 1080 academic hours
Module leader and assistant (if any)	exact scientific supervisor
Study terms	2nd year, 4th semester
Aim of the module To master theoretical and practical solution methods of energy saving and environmental safety in complex technological industries and complexes.	
Learning outcomes Preparation of the Master's Thesis and Final State Examination Valuable practical results of master thesis. Their application for the regional economy	

Assessment strategy and methods

- Internal current control of student progress according to IQ-net and ISO-9000 procedures (at the end of semester)
- Oral presentations
- Enterprise practice reports
- Professional portfolio
- Written reports, essays (including references, etc.)
- Tests after each topic, course exams, Master thesis assessment.
- Posters
- Peer review and evaluation by the group
- Self-evaluation

Quality assurance

Internal

- General expert evaluation by the Tempus project Evaluation board
- Students feedback

External

- Evaluation by European academics from partner universities
- Ministry of Education and Science of Russian Federation official recognition
- Evaluation by employers

Employment opportunities

Master programme graduates have the opportunity to be employed at power branches of industries (heat stations, boiler houses), chemical and mechanical engineering industries, in laboratories, scientific and research centres dealing with the problems of energy saving and energy efficiency improvement of industrial systems.

Learning resources available at the Chair (bought in the framework of the project)

№ п/п	Textbook title, data-line
1.	**Fuel and Energy Complex and Economy of Russia** English Publishing House: Energy Publising Centre
2.	**MATLAB and Simulink in Electric Power Engineering. Reference Book** Authors: V. P. Diakonov, A. A. Pen'kov
3.	**World Energy - 2050 (White Paper)** Editors: Vitaly Bushuev, V. Kalamanov English
4.	**English-Russian Dictionary of Energy (2 books set)** Author: A.S. Goldberg
5.	**Analysis and Planning of Power Consumption** Author: B. I. Makoklyuev
6.	**Wind Power Generators, Solar Batteries and Other Useful Constructions** Author: A. P. Kashkarov
7.	**Renewable Energy. Efficient Decisions** Author: V. M. Lyatkher
8.	**Renewable Energy** Author: A. B. Alkhasov
9.	**Heat Supply Sources and Systems** Author: V.Sh. Magadeev
10.	**Logistics** Author: Grigoriev M.N., Uvarov S.A.
11.	**Advanced Course of Logistics** Author: Grigoriev M.N, Dolgov A.P**.**
12.	**Beyond Oil and Gas: The Methanol Economy** Authors: G. Ola, A. Heppert, S. Prakash
13.	**Monitoring and Risk Assessment of Systems "Protection-Object-Environment"** Authors: Esipov Yu.V., Samsonov F.A.Cheremisin A.I.
14.	**Non-traditional and Renewable Sources of Energy.** M. Yu. Sibikin, Yu. D. Sibikin
15.	**Environment and Human Being** Author: E. I. Pochekaeva
16.	**Commercial Account Operators at Electric Power Markets. Technology and Organization of Activity** Author: L.K.Osika
17.	**Mastering Low-Potential Geothermal Heat** V.E. Fortov
18.	**Fundamentals of Heating Engineering. Heating Engineering Control and Boilers Automation** Author: B. A. Sokolov
19.	**Protection of Russian Environment in 2012.** Authors: V. Zhitkov, I. Voronina
20.	**Underground Accumulators of Energy Carriers in Power Engineering** Author: V. A. Kazaryan

21.	**Environment Protection Processes and Devices. Atmosphere Protection.** Author: N.E. Nikolaikina
22.	**Calculation, Analysis and Regulation of Electric Power Loss in Current Networks. Practical Calculations Manual** Authors: Yu. S. Zhelezko, A. V. Artemiev, O. V. Savchenko Russian
23.	**Russian-English Dictionary. English-Russian Dictionary. Electric Power Engineering** Author: E. Tursky
24.	**Workbook in Heating Engineering** Author: Yu.V. Sinyavski
25.	**Workbook in Hydraulics and Heat Engineering**
26.	**Workbook in Heating Engineering** Author: G. P. Pankratov
27.	**Liquefied Gas – Future of World Power Engineering** Authors: M. Mayorets, K. Simonov
28.	**Modern Problems of World Power Engineering** Author: Yu.V. Borovski
29.	**Solar Power Engineering** Authors: V. I. Vissarionov, G. V. Deryugina, V. A. Kusnetsova, N. K. Malinin Editor: V. Vissarionov
30.	**Reference Book. Bio-fuel Boilers and Electric Power Stations** Authors: Anton Ovsyanko, Pechnikov
31.	**Counters. Manual (+ CD-ROM)** Authors: Evgeny Akimov, M. Manukhin
32.	**Heat Power Engineering Systems and Energy Balances of Industries** Authors: Yu. G. Nazmeev, I. A. Konakhina
33.	**Technical Thermodynamics and Heat Transfer.** V. A. Kudinov, E. M. Kartashov, E. V. Stefanyuk
34.	**Physical Bases for Fuel Free Power Engineering. Restrictions of the Second Law of Thermodynamics** Author: E.G. Oparin
35.	**Ecology** Author: V. A. Razumov
36.	**Environment Safety and Environmental Law Problems of Pollution**
37.	**Power Supply and Power Consumption at Enterprises** Authors: E. F. Shcherbakov, D. S. Aleksandrov, A. L. Dubov
38.	**Power Supply of Objects** Author: E. A. Konyukhova
39.	**Electrical Power Engineering of Russia in 2030. Goals** Editor: V. Vainzikher
40.	**Power Engineering in Acronyms and Abbreviations. English-Russian Dictionary** Author: A. S. Goldberg
41.	**Energy of Hydrosphere** Author: D. A. Soloviev
42.	**Energy Saving in Communal Services.** Author: L.V. Primak
43.	**Energy Saving in Industries and Exergy Analysis of Engineering Processes** Author: E. E. Merker, G. A. Karpenko, I. M. Tynnikov
44.	**Energy Saving in Heat Power Engineering and Heat Technologies** Editor: Alexander Klimenko

45.	**Energy Saving and Production Automation in Municipal Heat Power Engineering. Variable Frequency Electric Drive** Authors: Yu. A. Krylov, A. S. Karandayev, V. N. Medvedev
46.	**Smart Grid** Author: Janaka Ekanayake
47.	**Smart Meters and the Smart Grid: Privacy and Cybersecurity Considerations (Energy Policies, Politics and Prices: Privacy and Identity Protection)**
48.	**Renewable Energy in Russia** Author: Jesse Russel
49.	**Fundamentals of Engineering Thermodynamics** Author: Michael J. Moran
50.	**Principles of Heat and Mass Transfer** Authors: Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine
51.	**World Renewa ble Energy Network** Author: Jesse Russell
52.	**Renewable Energy: Sustainable Energy Concepts for the Energy Change** Authors: Roland Wengenmayr, Thomas Buhrke
53.	**Applied Thermodynamics for Engineers** Author: Ennis William Duane
54.	**Thermodynamics** Author: Ennis William Duane

Curriculum map for Master Study-Programme "Innovative Technologies for Energy Saving and Environmental Protection "Green Master"

Module	A1	A2	A3	A4	A5	A6	A7	A8	B1	B2	B3	B4	B5	B6	B7	B8	B9	C1	C2	C3	C4	C5	C6	C7	C8
"Green technologies" of sustainable development	X		X	X		X	X		X			X	X	X	X		X	X	X			X		X	
Improvement of energy efficiency in natural and industrial systems		X	X			X	X	X	X			X	X	X				X	X		X	X	X		X
Energy life cycle, energy management and optimum decisions making	X	X	X	X			X	X	X	X		X	X	X		X		X	X	X	X	X		X	
Energy and environment audit		X	X		X			X	X	X		X		X		X				X	X		X	X	X
Fundamentals of thermodynamics and exergy analysis	X	X				X	X	X			X				X			X	X			X			
Engineering and economic analyses of energy saving activity	X	X	X	X				X				X		X		X	X	X	X	X	X	X		X	
Environmental control and modeling of energy efficient projects		X		X			X			X	X				X	X	X		X	X	X		X		X
Modeling of technological and natural systems		X	X	X			X					X	X				X		X		X		X		

Module	A1	A2	A3	A4	A5	A6	A7	A8	B1	B2	B3	B4	B5	B6	B7	B8	B9	C1	C2	C3	C4	C5	C6	C7	C8
Environmental safety and energy sustainable development	X			X	X			X	X	X				X		X		X	X		X	X	X		
English language for environmental studies History and significance of Bologna Process for higher education development																			X	X		X	X		X
Theory of energy efficiency for technosphere safety	X	X	X			X		X			X	X			X		X	X	X					X	
Scientific and research work in semester Scientific and research practice									X	X	X	X	X		X			X	X	X	X		X	X	
Master thesis									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

	Knowledge and Understanding		**B5**	Organize creative teamwork for complex inspection of industrial processes
A1	Gain knowledge of types of energy, energy generation peculiarities and transfer		**B6**	Use tools of power economy and industrial ecology diagnostics
A2	Understand methods of system approach to analysis and synthesis of energy consumption processes		**B7**	Develop work plans in energy saving
A3	Consider methods of technical and economical analysis of energy consumption processes		**B8**	Assess chosen scientific approaches to objectives solution
A4	Understand methods of optimal decisions search		**B9**	Assess environmental consequences of energy saving activities
A5	Acquire in-depth knowledge of energy and eco audit technology			**Graduate skills**
A6	Understand limit thermo-dynamic systems of energy consumption		**C1**	Develop critical thinking and carry out research (e.g. Present critically and compare their own views and those that differ from their own in native language and in English
A7	Understand necessity of complex study of research objects		**C2**	Identify and use various learning sources in students' scientific occupations.
A8	Gain knowledge of energy saving systems and equipment		**C3**	Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written and electronic modes of communication (in native language and in English).
	Practical Skills		**C4**	Make informed professional decisions based on scientific knowledge and appropriate criteria.
B1	Be able to inspect energy consumption systems to improve their energy efficiency and ecological safety		**C5**	Work effectively individually or in groups to accomplish assigned tasks.
B2	Use tools of power economy and industrial ecology diagnostics		**C6**	Develop efficient time management skills.
B3	Conduct energy and exergy balances of research objects		**C7**	Appreciate the social impact of research and practical work in the field of study
B4	Choose criteria for solution assessment in ecological and power systems		**C8**	Reflect and evaluate on own learning and evaluate peers in a professional manner.

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