COMPENDIUM

Master Programme

"INNOVATIVE TECHNOLOGIES FOR ENERGY SAVING AND ENVIRONMENTAL PROTECTION"

Voronezh State University of Architecture and Civil Engineering

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"

Co-funded by the
Tempus Programme
of the European Union

MASTER PROGRAMME

INNOVATIVE TECHNOLOGIES FOR ENERGY SAVING AND ENVIRONMENTAL PROTECTION "GREEN MASTER"

COMPENDIUM

VORONEZH STATE UNIVERSITY OF
ARCHITECTURE AND CIVIL ENGINEERING

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"

Tambov
2016

УДК [392 + 696/697]:504(035)
ББК 38.76я2
Ш64

Authors: Shitikova M.V., Semenov V.N., Semenova E.E.

Compendium. Design, construction and maintenance of power effective and eco-friendly buildings

Compendium is made by the TEMPUS project «GREENMA» partners. Compendium contains short information about master program "Design, construction and maintenance of power effective and eco-friendly buildings". Master program is designed in frame of TEMPUS project "LLL Training and Master in Innovative Technologies for Energy Saving and Environmental Control for Russian Universities, involving Stakeholders. «GREEN MASTER»
Master program aims, key competence and learning outcomes and also program structure, list of modules and theirs specifics, tests for summing up modules, description of teaching methods and an assessment criteria are presented.

Авторы: Шитикова М.В., Семенов В.Н., Семенова Э.Е.

Ш64 **Справочник по магистерской программе «Проектирование, строительство и эксплуатация энергоэффективных и экологичных зданий»:** учебное пособие [Текст]/ Шитикова М.В., Семенов В.Н., Семенова Э.Е - Тамбов: ООО «Рекон», 2016, 164 с.

Справочник составлен участниками проекта ТЕМПУС «ГРИНМА» и содержит краткие сведения о магистерской программе «Проектирование, строительство и эксплуатация энергоэффективных и экологичных зданий». Магистерская программа разработана в рамках проекта ТЕМПУС «Обучение в течение всей жизни и магистратура в области инновационных технологий в сфере энергосбережения и экологического контроля в российских университетах с участием работодателей «ГРИНМА». В справочнике представлены цели, приобретаемые компетенции и результаты обучения магистерской программы, а также структура программы, перечень изучаемых модулей и основные их характеристики, список вопросов к итоговому контролю по модулям, перечень учебной литературы, описание методов обучения и критериев оценки.

ISBN 978-5-9909811-4-0

Content

Foreword to Compendium

Energy problem is one of the most pressing global challenges of modern life as it affects the world population growth. The energy potential of any country represents its power, opportunities to improve citizens' life standards, strong position at the financial markets and overall national security. Energy provides operation of engines, computers, medical equipment, compressor stations, lighting systems, etc., which are now the attributes of technological progress.

Energy security of Russia is guaranteed by several opportunities:

- the great potential of explored and used natural recourses such as oil, gas, coal, peat, slate, wood, operating nuclear power plants and hydroelectric power plants;
- exploration and field development of new north hydrocarbon deposits;
- use of alternative eco-friendly energy sources: solar, wind, geothermal sources etc.;
- application of energy efficiency technologies in everyday life and in industries with the introduction of innovative technologies and equipment.

Use of energy saving opportunities in Russia is rather perspective as it prevents economic and ecological crisis and makes energy available for public. This direction of energy security improvement requires high-skilled specialists with systematic thinking, deep and complex knowledge of thermodynamics, economics, informatics, processes and devices, mathematical programming, etc.

The project TEMPUS 530620-TEMPUS-1-2012-I-IT-TEMPUS-JPCR being realized by the consortium of Russian and foreign universities is aimed at development of a new master study programme "Innovative Technologies for Energy Saving and Environmental Protection". The Russian Federation educational system has no analogues of such a programme.

The unique character of the programme is reflected in the recognition of the fact that all economic sectors should become low-cost, energy efficient and eco-friendly. It is evident that the consistent approach to train high-skilled professionals should be used and educational methodology should be based on natural and industrial systems theory, research of energy resources life cycle, interdisciplinary approach to the analysis of energy and environmental problems, use of "green technologies", comprehensive energy-technological, ecological and economic analysis of engineering solutions.

Methodological aspects of Master programme follow the European principles of "Bologna process", where much attention is paid to individual activity approach, master student is an active, creative subject of the study process. This type of training considers students' individual and psychological features, their personal skills, interests and needs.

Master programme presupposes use of special student-centred approach, which encompasses methods of teaching that shift the focus of initiative to master student. Application of such approach means the development of student's personal potential as a result of individual studies and development of partnerships between teachers and students: within this framework the students' independence is achieved in the study process, the student himself chooses the most effective way of learning.

Considering the Bologna process ideas, Master programme in energy saving and environmental control is based both on theoretical and practice-oriented methods of study, forming graduates' system of professional competences, providing easy adaptation to concrete working situation and masters' competitiveness at the labour market. The realization of practice-oriented methods of study, using the student-centred approach, is implemented in specialized innovative laboratories, formed at universities within TEMPUS project.

The achievement of Master programme aims is fostered by the group of Russian teachers, who completed intensive training course at Genoa University and get ready to develop and teach the new programme.

Didactic materials developed during the Master programme implementation are aimed at promoting both group and individual learning paths for master students. Regarding the series of so-called textbooks, representing important teaching and learning aids material, by this series the focus on the integration curricula among the involved Russian Universities has been stressed, as well as homogenous programmes between Russian and Members States' Universities have been achieved, together with widening and improvement of lecturers' knowledge of environmental technologies issues. These aims have been achieved also thanks to the cooperation with public authorities and business partners, exploiting new training and mobility methods for knowledge transfer and dissemination. This series, therefore, represents a result of international teaching experiences and a useful tool for students, teachers and researchers involved in environmental monitoring and energy saving processes. As well as for all those who needs a valuable professional support: technicians, engineers, chemists, managers who want to approach these topics.

The present volume has been produced undergoing to a complex process of revision, during which fundamental have been the contributions of the Russian National Tempus Office and the QUACING agency, appointed with the final revision. And the GREENMA management board has been very proud to present the final results in occasion of the international scientific conference held in Tambov in June 2016 on "V.I. Vernadsky: Sustainable Development of Regions".

In accordance with the perceiving of the Western Europe academic community, Vladimir lvanovich Vernadsky (1863-1945) was a scientist, originator of the modern theory of the Biosphere and the Noosphere, who promoted a scientific revolution and introduced a new paradigm of life studies. The importance of Vernadsky discoveries must be recognized as a new cultural and scientific revolution. His planetary vision of life has opened the road to holistic sciences and to Gaia hypothesis. This is the

concept called now “global ecology”, and handled by current Gaia followers.

Vernadsky has generated a deep innovation in a field of research that is a true «paradigm shift» in sciences as described in Thomas Kuhn’s vision of scientific revolution in humankind progress and his “Structure of Scientific Revolution”. The heritage of the Vernadsky thought has been duly considered in these years of cooperation between Russian and European Union Universities in the framework of joint projects, not only GREENMA, dealing with all the different aspects of environmental issues: juridical, policy and strictly technological ones.

Therefore, we wish also to give evidence of the outcomes and outputs achieved by some joint projects carried out along these years:

- the FRELP project dealing with “Environmental Law and Policy in Russian Universities, from September 2005 to June 2008;
- the NETWATER project dealing with “Network for Master training in technologies of water resources management”, from January 2010 until July 2013;
- the GREENMA project celebrated during the mentioned event;
- the MARUEEB project dealing with “Innovative Technologies in Energy Efficient Buildings for Russian & Armenian Universities and Stakeholders”, just started in October 2015.

The Vernadsky conference, together with the present volume, allow us to affirm that the main objectives and the different challenges planned by the GREENMA project can be considered achieved:

1. the establishment and implementation of Master Degrees designed in accordance with the latest Bologna Declaration requirements and keeping into account the labour market needs;
2. a process of harmonization of the Russian and European Union study programmes;
3. the creation of a Higher Education network among EU and Russian Universities and stakeholders for teaching, training and research in Environmental issues;
4. the development and enhancing of links among university - enterprises - labour market;
5. the involvement of junior academic staff by specific actions of empowerment and participation to the curricular reform processes;
6. attention to the projects sustainability over their lifecycles by improvement of innovation and technology transfer services;
7. permanent relationships with Regional Authorities, Associations of Entrepreneurs and the Ministry Agencies in order to get their support and recognition;
8. structural support to the process of curricular reform by publishing of the textbooks in co-authoring between Russian and European Union teachers, and setting-up of up-to-date didactical laboratories, some of them

equipped with modern pilot plants;

9. "last but not least" the stipulation of the GREENMA Network MoU aimed at disseminating knowledge on "Energy Saving and Environmental Control" and promoting the concept of the "Smart Cities and Communities".

As regards the feedback on the sustainable development at regional level, the network will represent a very useful tool:

- to plan the creation of cluster companies and spin-offs opportunities for graduates;
- to realize an integrated local system for research, training and innovation;
- to increase the competitiveness of the involved regions and to foster the exploitation of their socioeconomic features.

Therefore, by means of this foreword, we want to share the outcomes and outputs achieved until now and to everybody we address deep thanks, and we warmly invite everybody to trust in the capability of the participating Russian Universities to face the challenge for a Higher Education, which considers all the elements of the socioeconomic framework.

The warmest thanks must be expressed to the teams of the involved Russian Universities and stakeholders that had the strong wish to accept challenge of change and improvement process and have assured their fundamental help in the analysis of trends and structural changes in the Russian higher education system.

This challenge seems to be won and it will permit to the participating Universities, not only to consider this event just like the achievement of an outcome, but mainly to consider it the starting point for future further successes and challenges and to go toward the wider objectives for the establishment of the common space for education.

Thank you for your attention and for your contribution.

Tambov, September 2016

Dr. Liliya Mozerova

Mr. Angelo Musaio

Prof. Nikolay Popov

Master programme designers are sincerely grateful to the European Commission for the financial support of TEMPUS project.

Co-funded by the
Tempus Programme
of the European Union

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

Study-programme designed according to the EU dimension
(Learning outcomes approach)

Innovations:

- student-centred design
- fit for purpose
- learning outcomes - what graduates will know understand
- and will be able to do after the successful completing of the study programme
- organization related to the expected results

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 Yeltsin, 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

VORONEZH STATE UNIVERSITY OF ARCHITECTURE AND CIVIL ENGINEERING
2015

General Entry

Study programme designed according to the EU dimension (Learning outcomes approach)

Innovations:

- Student-centered designed
- Fit for purpose
- Learning outcomes what graduates will know understand and dill be able to do after the successful completing of the study programme
- Organization related to the expected results

University	**Voronezh State University of Architecture and Civil Engineering, Voronezh, Russia**
Programmelevel	**Master level**
Status	**Joint International Programme**
Name of the course	**Design, construction and maintenance of power effective and eco-friendly buildings**
Field and classification code	**Civil Engineering** **270800 (Russian education classification code)**
Qualification	**Master of Engineering and Technology**
Web-site	**http://vgasu.vrn.ru**
Institute	**Faculty of Civil Engineering and Faculty of Architecture**
Address	**84, 20-letiya Oktybrya Street, Voronezh, 394006**
Course length	**2 years**
Workload	**120 credits (in accordance with ECTS)** **4,320 academic hours (in accordance with Russian education standard)**
Startdate	**September 2014**
Professional recognition	**Stakeholders consulted for the designing of the study-programme:** **- Department of Architecture and Civil Engineering Policy of Voronezh Region** **- 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** **- Voronezh Design Institute "VoronezhProekt"**
Teaching organization	**Semester modules, front lectures, field visits, laboratory works, individual work, scientific supervising, Master thesis preparation**

Preliminary statement:

The students' workload in the Russian Federation is based upon academic hours. An academic hour means 45 minutes according to the regulations for Higher Education. These measures are settled in order to harmonize the Russian Federation academic system with the one of the Bologna Declaration. The following methodology guidelines are suggested from the Russian Ministry of Education and Science in order to boost the introduction of the ECTS to Russian universities.

The term "Zachetnaya edinitsa" ("Passing unit") was introduced and so-called "Russian credit unit" (RCU) is considered to be equal to 1 ECTS credit unit.

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

- 1 Russian credit unit (RCU) = 36 academic hours
- 1 academic week = 54 academic hours = 1.5 RCU
- Discipline workload is calculated by dividing academic hours by 36
- 1 practical training week = 1.5 RCU
- 1 exam = 1 RCU
- Final qualification work (project), (1 week = 1.5 RCU)

Aims of the programme:

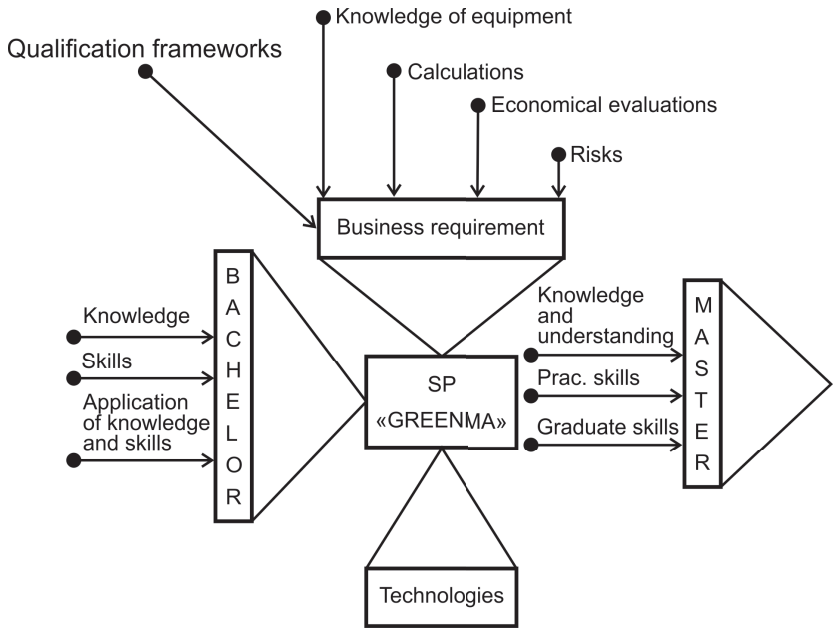
The programme aims to:

1. provide Green Master students with the opportunity to deepen their knowledge of innovative technologies for energy saving in Civil Engineering and environmental protection;
2. provide students with the special knowledge and understanding of sustainable development concerning efficient use of energy resources via adopting a broad analytical holistic approach to sustainable management in energy saving and environmental control which integrates theory and practice;
3. develop student competences in a range of research methodologies dealing with the development and distribution of energy saving technologies in Civil Engineering and architectural environment;
4. develop student abilities to solve the problem arising during all stages of design, construction and maintenance of power effective and eco-friendly buildings;
5. provide the analytical skills needed at an advanced level to manage, critically evaluate and assess development in the area of energy saving and efficient use of natural resources to improve competitiveness due to cost reduction;
6. develop students' ability to critically review the links between global problems and policies and local management actions;
7. provide students with the knowledge and skills needed to develop a career in the field of design, construction and maintenance of power effective and eco-friendly buildings, as well as alternative and renewable energy sources.

GREENMA master develop the following competence and soft 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 nonconventional technologies.

Study-programme model:



The educational needs of the labour market and other stakeholders

The scope of the graduate professional activities, the types and tasks of these activities are specified by Federal State Higher Educational Standard dated 30 October 2014 (http://www.fgosvo.ru).

Design, construction and maintenance of power effective and eco-friendly buildings are the objects of the graduate professional activities.

Programme purposes and tasks are agreed with the stakeholders of the educational relationship, including employers – social partners.

1. Federal State Institution of Civil Engineering
2. The ministry of construction and infrastructure development of Voronezh region
3. StroyProekt Ltd.
4. JSC “Voronezhpromstroy”
5. “The company CENTROPROEKT” Ltd.
6. “TECHCON” Ltd.
7. “Construction Company OBLPROM” Ltd.
8. Union of design, research and survey of enterprises and organizations of the Voronezh region
9. Design and investment company “Voronezh GrazhdanProekt” Ltd.
10. Union of Civil Engineers of Voronezh region

In accordance with the qualification, graduates will be able to realize their professional activities in the field of:

- engineer support and equipping of construction projects and urban areas as well as transport infrastructure;
- engineering survey in construction;
- realization of research studies and educational activities.

Graduates will be able to perform professional activity in:

- design organizations;
- construction, production and erection associations;
- organizations involved in construction object expertise;
- industrial and utility enterprises;
- public and municipal authorities;
- research organizations;
- educational establishments of a proper type.

The following competences should be developed as the result of graduates' programme mastering:

Knowledge and Understanding

- know and understand the fundamental laws of applied disciplines in the Master programme;
- applying Knowledge and Understanding;
- develop physical and mathematical (computer) models of phenomena and objects relevant to graduates' activity profile;
- develop technologies, targets and programmes of research and projects realization, prepare assignments for performers, organize experiment and test realization, analyze and summarize the results obtained.

Making Judgements

- be able to interpret correctly the results of calculations performed by means of CAD software and mathematical modelling.

Communications (and Team-working) Skills

- be able to act in non-typical situations, to bear social and ethical responsibility for decisions made;
- be ready to communicate verbally and in writing in Russian and foreign languages to solve tasks within the professional activity;
- be ready to be in charge of a team in the field of graduate's professional activity.

Learning Skills

- acquire independently new knowledge and skills by means of information technologies and practice them in new areas of knowledge that are not directly related to graduate's professional activity, widen and deepen his scientific world outlook.

Key Competences	**Programme Learning Outcomes**
1. Know and understand fundamental laws of applied disciplines in the MA course; 2. Be able to act in non-typical situations, to bear social and ethical responsibility for decisions made; 3. Demonstrate the level of thinking, the ability to analyze scientifically socially significant problems and processes.	The ability to shape independently contemporary scientific view of the world realizing own social responsibility for consequences of professional activity.

1. Demonstrate the level of thinking, the ability to analyze scientifically socially significant problems and processes; 2. Be able to study independently in order to choose appropriate methods of theoretical and experimental investigation and analysis of results; 3. Estimate the correctness and consistency of the selected methods of testing; 4. Be able to analyze the problems of scientific and technical development of modern society.	The ability to apply profound theoretical and practical knowledge and to acquire new experience in special method development to solve non-standard research and project tasks in the area of energy saving and design, construction and maintenance of power effective and eco-friendly buildings.
1. De able to schedule training; 2. Estimate the quality of teaching material learned by students; 3. Be able to develop and realize oneself using creative potential.	The ability to perform various types of teaching and guiding activities at high professional level.
1. Be able to communicate and negotiate in a foreign language with different stakeholders; 2. Be able to study independently the sources of literature in foreign languages; 3. Be able to improve constantly a spoken foreign language.	The ability to communicate verbally and in writing in a foreign language to achieve tangible results in the process of studying, research or career in the area of energy saving systems and design, construction and maintenance of power effective and eco-friendly buildings.
1. Be able to use statistical methods of hypotheses verification; 2. Be able to derive regression equation and to value its components; 3. Have basic methods of ordinary differential equation solutions and their systems; 4. Lay down initial and boundary conditions for differential equation solutions of various types.	The ability to collect, analyze and systemize the information about construction objects with the help of information technologies including those applied in new areas of knowledge that are not directly related to graduate's professional activity for the purpose of widening and deepening graduate's scientific world outlook.
1. Have skills of scientific and technical problem statement, of methodical method and solution techniques selection;	The ability to organize, plan and carry out research activities independently, to present results, to find organizational and managerial

2. Have skills of collecting, processing and analyzing results, of theory and experiment identification; 3. Have skills of independent planning and carrying out research activities.	decisions in non-typical situations, and the ability to bear responsibility for these decisions made.
1. Estimate the validity of mathematical modelling results and their validation in a modelling object; 2. Have skills of computer-aided design of energy efficient systems in Civil Engineering; 3. Use estimation methods during designing power effective and eco-friendly buildings in terms of their reliability, energy and ecological efficiency.	The ability to design, construct and maintain power effective and eco-friendly buildings by means of modelling techniques, automated analysis and design in course of research and engineering activities.
1. Be able to choose methods of specific problem solutions; 2. Acquire skills of task formalization; 3. Acquire skills of modelling result analysis and adequate assessment.	The ability to model mathematically phenomena and processes of engineering systems for numerical investigations, modelling result analysis for the purpose of choosing optimal energy efficient decisions in course of research and engineering activities.
1. Be able to choose methods of specific problem solutions; 2. Acquire skills of task formalization; 3. Acquire skills of modelling result analysis and adequate assessment.	The ability to solve the systems of differential equations of various types using general and special software for the purpose of energy efficient processes and equipment design.
1. Model life-circuits in static conditions and transient processes; 2. Use independently computational models when designing energy efficient buildings; 3. Demonstrate the skills of data transfer into various software.	The ability to use special software in designing energy efficient buildings.

1. Be able to analyze current state of the economy of an enterprise, region or country; 2. Use contemporary methods of state estimation, sustainability and efficiency management of construction company operation;	The ability to analyze economic aspects of the utilization of energy saving technologies and renewable energy sources.
3. Evaluate internal and external environmental impacts on the state of a construction company by means of expert method.	
1. Solve technical problems applying theoretical concepts and practical knowledge in industry; 2. Select and put into practice adequate methods and technologies to diagnose and estimate technical state of energy efficient equipment.	The ability to select and practice adequate methods and technologies to diagnose and estimate technical state of energy efficient equipment for providing operational reliability and sustainability.
1. Use technical and economic methods to study energy saving activities used in design and operation of construction objects; 2. Use energy investigation methods in buildings and structures; 3. Be able to make building energy rating certificate.	The ability of making decision aimed at effective utilization of energy resources in research and design activities.
1. Have skills of scientific and technical problem specification, of methodology selection and its solution means; 2. Be able to collect, process and analyze results, to identify theory and experiment; 3. Be able to plan and carry our research independently; 4. Have skills of writing scientific and technical report.	The ability to achieve results that can be introduced into production, regional economy, socio-economic sphere or writing Master's thesis.

Programme languages: Russian and English

Admission criteria:

- Bachelor or Specialist degree in a relevant branch of Science or Engineering; work experience in the field is appreciated.
- English language (to be assessed by an interview) including the knowledge of Civil Engineering terminology.
- Foreign candidates are required to have the certificate of Russian language course attendance at B1 level or higher.

Teaching methods

Seminars, academic advising, practical work, creative workshops, problem solution classes, laboratory classes, internships, mobilities, e-learning.

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

1. Tuning methodology;
2. Dublin descriptors;
3. ECTS.

Programme structure

Compulsory subjects (SES – a discipline required by the State educational standards of the Russian Ministry of Education and Science)

- Philosophical problems of science and technology (SES)
- The methodology of scientific research (SES)
- Special sections of mathematics (SES)
- Mathematical modelling (SES)
- Basics of pedagogy and androgogics (SES)
- Business foreign language (SES) and English Civil Engineering terminology
- Information technology in Civil Engineering (SES)
- Methods for solving scientific and technical problems in Civil Engineering
- Standards and legal base of energy saving
- Modern world experience of the solution of energy saving problems and increase of efficiency of energy utilization
- Life cycle of energy resources and real estate objects
- The main trends of energy saving at design, construction and maintenance of buildings
- Theory and practice of increase of energy efficiency
- Methodology of fitting the cycle dynamics of energy resources and real estate objects
- Energy balance and energy audit
- Methodology of assessment of the efficiency of energy saving technologies implementation

Elective subjects

- Programme-aided methods for increasing the energy efficiency
- Advanced problems of energy saving in Architecture
- Ecological safety and power sustainable development
- Renewable energy sources
- Economic justification of application of energy saving technologies
- Ecological aspects of investments in civil engineering projects
- "Green construction" for sustainable development of territories
- Utilization of secondary energy sources

Practice and research experience (SES)

Master's thesis (SES)

GREENMA programme learning outcomes

The possession of master key competences should be achieved through the programme learning outcomes, given in the table.

<table>
<tr><th colspan="2">Programme Outcomes</th></tr>
<tr><td rowspan="2">A. Knowledge and understanding
1. Fundamental knowledge and understanding of innovative technologies in energy saving and environmental control.
2. Understanding of optimization approach and methods of energy and resource saving processes.
3. Understanding of energy saving as the basis of green technologies development.
4. Knowledge of administrative authorities and legislation in the field of environmental protection and energy saving.
5. In-depth knowledge of design, construction and maintenance of energy efficient buildings and energy saving technologies.
6. Knowledge of mathematical and analytical concepts and models for solving energy saving problems on all stages of design, construction and maintenance of energy efficient buildings.
7. Critical evaluation of current methods of energy production and utilization.</td><td>Teaching/learning methods
Students gain knowledge and understanding through lectures, seminars and laboratories attendance. 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.</td></tr>
<tr><td>Assessment methods
Students’ knowledge and understanding are assessed by a variety of methods such as tests, laboratory reports, case study analysis, student presentations and examinations.</td></tr>
<tr><td>B. Practical skills
1. Ability to provide engineering and managerial input into planning of energy and resource saving projects and facilities.
2. Ability to solve engineering problems through the application of theoretical knowledge and practical skills in industrial environment.</td><td>Teaching/learning methods
Students acquire cognitive skills through participating in seminars and laboratories, doing group and mini group projects, making case study analysis, having field trips, preparing student presentations.
Electronic resources will also be used to enhance student cognitive skills.</td></tr>
</table>

<table>
<tr><td>3. Ability to carry out laboratory and field experiments, collect, analyse and interpret data.
4. Select and use appropriate methods and technologies for energy and resource saving.
5. Use appropriate Information Technology for engineering and management purposes.
6. Ability to design the energy effective buildings.</td><td>Assessment methods
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 classify, assess, discuss, interpret and manipulate.</td></tr>
<tr><td rowspan="2">C. Graduate skills
1. Develop critical thinking and carry out research (e.g. compare their views and those that differ from their own both in Russian and English).
2. Identify and use various learning sources in learning activities.
3. Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written, and electronic ways of communication (both in Russian and English).
4. Make 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. Evaluate social impact of research and practical work in the field of study.
8. Personal and peers' reflection and evaluation of learning outcomes.</td><td>Teaching/learning methods
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, and specific modules attendance. Electronic resources will also be used to enhance student cognitive skills.</td></tr>
<tr><td>Assessment method
Students' graduation skills are assessed by dissertation module, laboratory reports, essays, group project and data analysis assessment.</td></tr>
</table>

Module determination by semesters, teachers and credits

Title of the discipline	Credit points (per semester)	Type of assessmenti in current semester	Academic staff
SEMESTER 1			
M1.1. Philosophical problems of science and technology	2	Written paper, test	Docent Volkova E.S.
M1.3. Fundamentals of pedagogy and androgogy	2	test	Prof. Radugin A.A.
M1.4. Business foreign language	3	test	Docent Lukina L.V.
M2.1. Mathematical modeling	2	test	Prof. Golovinski P.A.
M3.1. Standards and legal base of energy saving	2	examination	Docent Isanova A.V.
M3.2. Modern world experience of the solution of energy saving problems	4	examination	Docent Kononova M.S.
M3.3. Bases of energy saving and increase of power efficiency	3	examination	Prof. Semenov V.N.
M5.1. Power balance and energy audit	2	examination	Docent Isanova A.V.
M6.1. Ecological assessment and audit	3	test	Prof. Sazonov E.V.
	23		
SEMESTER 2			
M1.2. Methodology of scientific research	2	test	Prof. Shitikova M.V.
M2.2. Special sections of the higher mathematics	2	Written paper, test	Prof. Sedaev A.A.
M3.1. Standards and legal base of energy saving	2	test	Docent Isanova A.V.
M4.1. Life cycle of energy resources and real estate objects	4	test	Prof. Semenov V.N.

M4.3. The main trends of energy saving at design, construction and maintenance of buildings	2	Course project, examination	Docent Semenova E.E.
M5.3. ‘‘Green construction’’ for a sustainable development of territories	3	test	Docent Bogatova T.V.
M8.2. Research work during semester	16,5	test	
M8.1. Research practice	3	test	
M8.1. Pedagogical practice	3	test	
	37.5		
SEMESTER 3			
M2.3. Information technologies in civil engineering	3	examination	Docent Proskurin D.K.
M2.4. Methods of the solution of scientific and engineering tasks in civil engineering dealing with energy saving and efficiency	2	test	Prof. Shitikova M.V.
M4.1. Life cycle of energy resources and real estate objects	4	examination	Prof. Semenov V.N.
M7.1. Methodology of the assessment of energy saving procedures	2	test	Docent Vorobieva Yu.A
M4.2. Methodology of cyclic dynamics of energy resources and real estate objects	2	test	Prof. Semenov V.N.
M5.2. Program-aided methods for increasing the energy effectiveness	3	test	Docent Kitaev D.N.
M6.2. Ecological safety and power sustainable development	3	examination	Prof. Sazonov E.V.
M7.2. Assessment of technologies of increase of power efficiency	3	test	Prof. Sazonov E.V.
	22		

SEMESTER 4			
M8.2. Scientific and research work	34,5	test	
M9. Final state examination, Master thesis defense	3		
	37,5		
Total for 4 semesters	**120**		

Module indication

Module 1 Title	**Theoretical bases of scientific research**
Course Titles	M1.1. Philosophical problems of science and technology M1.2. Methodology of scientific research M1.3. Fundamentals of pedagogy and androgogy M1.4. Business foreign language
Credits	Total: 9 credits, 324 academic hours M1.1. 2 ECTS credits, 72 academic hours M2.2. 2 ECTS credits, 72 academic hours M2.3. 2 ECTS2 credits, 72 academic hours M2.4. 3 ECTS credits, 108 academic hours
Module leader and assistant (if any)	Prof. Shitikova M.V.
Study terms	M1.1. Year 1, semester 1 M1.2. Year 1, semester 2 M1.3. Year 1, semester 1 M1.4. Year 1, semester 1
Aim of the module The course introduces students to the current problems of scientific and technological development of modern society. Preparation of students to study new advanced concepts in Civil Engineering based on energy saving technologies. In-depth study of English as a language for adaptation for specific terminology in the field on energy saving on all stages of design, construction and maintenance of energy efficient buildings and structures, for reading special scientific and engineering literature, for utilizing international information data basis, for communication with colleagues in research and work teams. Study of the history and significance of Bologna Process for higher education development.	
Lectures	Semester 1: 36 hours Semester 2: 36 hours
Laboratory works, seminars	Semester 1: 108 hours Semester 2: 18 hours
Individual work	Semester 1: 108 hours Semester 2: 18 hours
Module Learning outcomes **Knowledge and understanding:** • forms and methods of scientific knowledge • advanced trends in current scientific knowledge • English as a language of business communication	

Practical skills

- selection and implementation of methods of scientific research
- analysis of the problems of scientific and technological development of modern society
- development trends and perspectives of technological society
- oral and written English for business purposes

Graduate (or Transferable) skills

- ability for adaptation for advanced aspects and methods in Civil Engineering
- methods of scientific explanation and prediction based on energy saving technologies
- level of English required for work in an international interdisciplinary team

Assessment methods

Students' knowledge and understanding are assessed by a variety of methods such as tests, students presentations and examinations.

Module Learning Outcomes	**Contents and/or Educational Activities that contribute to the achievement of the MLO**
The ability to orient in the world of science and technology in conditions of technicalization of humanitarian relations.	Know trends of scientific knowledge development.
	Be able to analyze the problems of scientific and technical development of contemporary society.
	Know forms of scientific knowledge.
The ability to use philosophic methodology in unity with scientific cognition methodology.	Understand methodological unity and diversity of modern science.
	Understand scientific rationality and its historic types.
	Be able to select research methods and the ways of their realization.
The ability to articulate thoughts consecutively, logically and conclusively.	Have the concepts of problems, hypothesis and theory, scientific law as the scientific knowledge element.
	Demonstrate the principles of thinking.
	Estimate the accuracy and consistency of accepted research methods.

The ability to get over the extremes of subjectivism and objectivism in obtaining objective truth.	Know forms and methods of scientific cognition.
	Know empirical and theoretical scientific methods.
The ability to defend values and ideas in the realization of corporate and production interests (axiological ability).	Understand mathematization and computerization of modern science.
	Estimate the role of innovations and traditions of modern science. Estimate perspectives of modern scientific formulations.
	Be able to analyze socially significant problems and processes in the field of energy saving and ecology.
The ability to communicate orally and in writing in a foreign language for success in process of training, research or career in the area of energy efficient systems of heat and gas supply and ventilation.	Know and understand the principles and rules of grammar, phrase formation and general and professional vocabulary.
	Acquire skills necessary for successful communication with native speakers in personal or professional environment.
	Understand a text in a foreign language.
	Translate texts from Russian into a foreign language.
	Be able to communicate and negotiate with stakeholders using a foreign language.
	Be able to learn independently the sources of literature in foreign languages.
Module Learning Outcomes	**Teaching / learning method and Criteria of Assessment**
The ability to orient in the world of science and technology in conditions of technicalization of humanitarian relations	lectures
	seminars, public speech, debating
	oral examination
The ability to use philosophic methodology in unity with scientific cognition methodology	lectures
	seminars, public speech, debating
	paper submission
	oral examination
The ability to articulate thoughts consecutively, logically and conclusively	Seminars, oral presentation, debating
	oral examination

The ability to get over the extremes of subjectivism and objectivism in obtaining objective truth	lectures
	seminars, oral presentation, debating
	oral examination
The ability to defend values and ideas in the realization of corporate and production interests (axiological ability)	seminars, oral presentation, debating
	paper opponency
	oral examination
The ability to communicate orally and in writing in a foreign language for success in process of training, research or career in the area of energy efficient systems of heat and gas supply and ventilation	translation of texts related to the area of energy efficient systems of heat and gas supply and ventilation
	oral presentations
	credit test
	examination

Module 2 Title	**Mathematical analysis and modeling of power effective systems**
Course Titles	M2.1. Mathematical modelling M2.2. Special sections of the higher mathematics M2.3. Information technologies in civil engineering M2.4. Methods of the solution of scientific and engineering tasks in civil engineering dealing with energy saving and efficiency
Credits	Total: 9 credits, 324 academic hours M1.1. 2 ECTS credits, 72 academic hours M2.2. 2 ECTS credits, 72 academic hours M2.3. 2 ECTS2 credits, 72 academic hours M2.4. 3 ECTS credits, 108 academic hours
Module leader and assistant (if any)	Prof. Shitikova M.V.
Study terms	M2.1. Year 1, semester 1 M2.2. Year 1, semester 2 M2.3. Year 2, semester 3 M2.4. Year 2, semester 3
Aim of the module The main aim of the module is to acquaint students with the advanced methodology of mathematical modelling needed for the reduction of the problem to be solved to the set of differential equations describing adequately the object under consideration. Students should get general knowledge and skills on mathematical formulation of the physical problem, derivation of governing equations in differential or integral form with further their analytical and/ or numerical analysis. Students should also gain the skills for providing the comparison and estimation of divergence of the mathematical modelling results from experimental measurements. In-depth knowledge of advanced information technologies applicable for solving the problems arising in Civil Engineering.	
Lectures	Semester 1: 36 hours Semester 2: 36 hours Semester 3: 36 hours
Laboratory works, seminars	Semester 1: 18 hours Semester 2: 18 hours Semester 3: 108 hours
Individual work	Semester 1: 18 hours Semester 2: 18 hours Semester 3: 36 hours

Module Learning outcomes

Knowledge and understanding:

- advanced methods of mathematical analysis for solving the problems of energy saving
- detection and analysis of current problems of energy saving and their description with adequate mathematical models
- advanced information technologies

Practical skills

- selection and implementation of methods of research
- analysis and generalisation of the results of scientific research
- ability and willingness to apply the knowledge on modern methods of research in engineering practice
- application of new information technologies in research and engineering practice

Graduate (or Transferable) skills

- the choice of methods of theoretical and experimental verification of the adequacy of mathematical models adopted for solving different engineering problems
- skills to evaluate the adequacy and accuracy of the solutions obtained
- all-life learning of information technologies.

Assessment methods

Students' knowledge and understanding are assessed by a variety of methods such as the analysis of analytical and numerical research exercises, laboratory work, tests, students presentations and examinations.

Module Learning Outcomes	**Contents and/or Educational Activities that contribute to the achievement of the MLO**
The acquisition of mathematical modelling skills to describe phenomena and processes in engineering systems.	Study modelling principles based on differential equations of various types and boundary condition tasks.
	Study the principles of validity estimation of calculated results.
The acquisition of mathematical modelling skills based on fuzzy logics.	Study basic notions of fuzzy logics: fuzzy variables, fuzzification, fuzzy dediction, defuzzification.
The acquisition of optimization modelling skills based on genetic algorithm.	Study basic notions and principles of genetic algorithms formation.

Module Learning Outcomes	Method and Criteria of Assessment
The acquisition of mathematical modelling skills to describe phenomena and processes in engineering systems	lectures
	independent task solution
	credit test
The acquisition of mathematical modelling skills based on fuzzy logics	lectures
	independent task solution
	literature source study, paper preparation
	credit test
The acquisition of optimization modelling skills based on genetic algorithm	lectures
	independent task solution
	literature source study, paper preparation
	credit test
Module Learning Outcomes	**Course units**
The acquisition of mathematical modelling skills to describe phenomena and processes in engineering systems	written reports
The acquisition of mathematical modelling skills based on fuzzy logics	oral presentations
	written reports
The acquisition of optimization modelling skills based on genetic algorithm	oral presentations
	written reports

Module 3 Title	**Standards of energy saving ensuring and increase of power efficiency**
Course Titles	M3.1. Standards and legal base of energy saving M3.2. Modern world experience of the solution of energy saving problems M3.3. Bases of energy saving and increase of power efficiency
Credits	Total: 9 ECTS credits, 324 academic hours M3.1. 2 ECTS credits, 72 academic hours M3.2. 4 ECTS credits, 144 academic hours M3.3. 3 ECTS credits, 108 academic hours
Module leader and assistant (if any)	
Study terms	M3.1. Year 1, semester 1 M3.2. Year 1, semester 1 M3.3. Year 1, semester 1
Aim of the module Gain the in-depth knowledge of standards and legal base of energy saving in Russia and EU countries, the comparison of their merits and demerits. Studying of modern world experience in solving the energy saving problems from different points of view. Advanced methods of increasing the power efficiency.	
Lectures	Semester 1: 30 hours
Laboratory works, seminars	Semester 1: 60 hours
Individual work	Semester 1: 234 hours
Module Learning outcomes **Knowledge and understanding:** • standards and legal base of energy saving • up-to-date world experience of the solution of energy saving problems • methods resulting in the increase of power efficiency **Practical skills** • application of standards and legal base of energy saving in engineering practice • application of up-to-date world experience of the solution of energy saving problems in research • implementation of advanced methods resulting in the increase of power efficiency at all stages of design, construction and maintenance of buildings **Graduate (or Transferable) skills** • select the most efficient method for solving any particular problem • skills to evaluate the efficiency of the solutions obtained	

Assessment methods Students' knowledge and understanding are assessed by a variety of methods such as tests, students presentations and examinations.	
Module Learning Outcomes	**Contents and/or Educational Activities that contribute to the achievement of the MLO**
The study of economic aspects of energy saving technologies and renewable energy resource utilization.	Know basic principles of models of developing enterprise economic sustainability.
	Know techniques of analyzing the state of the economy of an enterprise, region or country.
	Know methods of evaluating internal and external environmental impacts on construction company state with expert method.
The study of ways to provide economic sustainability of enterprises and organizations in construction industry.	Know principal approaches of evaluating sustainability used both in Russia and abroad.
	Know the ways of applying modern methods to evaluate the state, sustainability management and effectiveness of construction company operation.
Module Learning Outcomes	**Teaching / learning method and Criteria of Assessment**
The study of economic aspects of energy saving technologies and renewable energy resource utilization	lectures
	seminars
	examination
The study of ways to provide economic sustainability of enterprises and organizations in construction industry	lectures
	seminars
	literature sources study, paper preparation
	examination
Module Learning Outcomes	**Course units**
The study of economic aspects of energy saving technologies and renewable energy resource utilization	written reports
The study of ways to provide economic sustainability of enterprises and organizations in construction industry	oral presentations

Module 4 Title	**Methodology of energy saving and increase of energy efficiency**
Course Titles	M4.1. Life cycle of energy resources and real estate objects M4.2. Methodology of fitting the cyclic dynamics of energy resources and real estate objects M4.3. The main trends of energy saving at design, construction and maintenance of buildings
Credits	Total: 10 ECTS credits, 360 academic hours M4.1. 4 ECTS credits, 144 academic hours M4.2. 3 ECTS credits, 108 academic hours M4.3. 3 ECTS credits, 108 academic hours
Module leader and assistant (if any)	Prof. Semenov V.N.
Study terms	M4.1. Year 1, semester 2, Year 2, semester 3 M4.2. Year 2, semester 3 M4.3. Year 1, semester 2
Aim of the module The in-depth knowledge of life cycle of energy resources and real estate objects of various purpose and their interrelation. Methodology of evaluating and estimation of efficiency of cyclic dynamics of energy resources and real estate objects during their construction and maintenance. The formulation, evaluation and estimation of the main trends of energy saving at all stages of design, construction and maintenance of energy efficient buildings, and their utilization in engineering daily practice.	
Lectures	Semester 2: 54 hours Semester 3: 18 hours
Laboratory works, seminars	Semester 2: 108 hours Semester 3: 18 hours
Individual work	Semester 2: 54 hours Semester 3: 36 hours
Module Learning outcomes **Knowledge and understanding:** • Methods of the analysis and description of life cycle of energy resources and real estate objects • Methodology of cyclic dynamics of energy resources and real estate objects • Advanced energy saving technologies useful for design, construction and maintenance of energy efficient buildings **Practical skills** • To analyze the life-cycle of different energy resource	

- To apply the methodology of cyclic dynamics of energy resources and real estate objects for the estimation of their current state
- To apply the advanced energy saving technologies for design, construction and maintenance of energy efficient buildings

Graduate (or Transferable) skills

- To create the energy efficient buildings
- Skills to deep into the new energy saving technologies using information from the literature.

Assessment methods

Students' knowledge and understanding are assessed by a variety of methods such as tests, course project, students presentations and examinations.

Module Learning Outcomes	**Contents and/or Educational Activities that contribute to the achievement of the MLO**
The study of basics to theory and practice to provide the quality and reliability of equipment of various types and purposes.	Know basic requirements to the design of heating, ventilation and air conditioning systems in terms of energy conservation.
	Know methods to provide quality and reliability of equipment.
The study of types and organization of service and regulation of equipment.	Know the organization of maintenance of equipment.
	Know methods to handle equipment.
The study of methods to assess technical condition of engineering systems.	Know basic methods to evaluate the technical condition of heating, ventilation and air conditioning systems.
	Know technical diagnostic tools.
Module Learning Outcomes	**Teaching / learning method and Criteria of Assessment**
The study of basics to theory and practice to provide the quality and reliability of equipment of various types and purposes	lectures
	seminars
	credit test
The study of types and organization of service and regulation of equipment	lectures
	seminars
	literature sources study, paper preparation
	credit test

The study of methods to assess technical condition of engineering systems	lectures
	seminars
	literature sources study, paper preparation
	credit test
Module Learning Outcomes	**Course units**
The study of basics to theory and practice to provide the quality and reliability of equipment of various types and purposes	written reports
The study of types and organization of service and regulation of equipment	oral presentations
The study of methods to assess technical condition of engineering systems	oral presentations

Module 5 Title	**Theory and practice of increase of energy efficiency**
Course Titles	M5.1. Power balance and power audit M5.2. Program-aided methods for increasing the power efficiency M5.3. «Green construction» for a sustainable development of territories M5.4. English Civil Engineering terminology
Credits	Total: 13 ECTS credits, 468 academic hours M5.1. 4 ECTS credits, 144 academic hours M5.2. 3 ECTS credits, 108 academic hours M5.3. 3 ECTS credits, 108 academic hours M5.4. 3 ECTS credits, 108 academic hours
Module leader and assistant (if any)	Prof. Semenov V.N.
Study terms	M5.1. Year 1, semester 1 M5.2. Year 2, semester 3 M5.3. Year 1, semester 2 M5.4. Year 1, semester 2
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 programs 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.	
Lectures	Semester 1: 18 hours Semester 2: 18 hours Semester 3: 72 hours
Laboratory works, seminars	Semester 1: 36 hours Semester 2: 54 hours Semester 3: 72 hours
Individual work	Semester 1: 18 hours Semester 2: 36 hours Semester 3: 72 hours
Module Learning outcomes **Knowledge and understanding:** • 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 conditions and audit tools
- Understand technologies of energy saving in branches
- Gain knowledge of «Green construction» for a sustainable development of territories

Practical skills

- Organize energy audit
- Recording/documenting audit results
- Statistical methods of data processing
- Develop recommendations
- Make audit reporting
- Implement practical recommendations on the application of energy saving technologies in daily engineering practice

Graduate (or Transferable) skills

- Define goals and objectives of energy and audit
- Choose assessment criteria for inspection results
- Prepare presentational materials
- Prepare forms to make the conclusion

Assessment methods

Students' knowledge and understanding are assessed by a variety of methods such as tests, students presentations and examinations.

Module Learning Outcomes	**Contents and/or Educational Activities that contribute to the achievement of the MLO**
The study of methods of systematic inspection of industries for energy efficiency and environment safety.	Know basic principles of energy efficiency.
	Know techniques of analyzing the environment safety.
	Know methods of ''Green construction'' for a sustainable development of territories.
The study of audit conditions and audit tools.	Know principal approaches of evaluating audit tools used both in Russia and abroad.
	Know the ways of applying modern methods of energy audit.
Module Learning Outcomes	**Teaching / learning method and Criteria of Assessment**
The study of methods of systematic inspection of industries for energy efficiency and environment safety	lectures
	seminars
	examination

The study of audit conditions and audit tools	lectures
	seminars
	literature sources study, paper preparation
	examination
Module Learning Outcomes	**Course units**
The study of methods of systematic inspection of industries for energy efficiency and environment safety	written reports
The study of audit conditions and audit tools	oral presentations

Module 6 Title	**Environmental problems of energy saving and ways of their decision**
Course Titles	M6.1. Environmental assessment and audit M6.2. Ecological safety and power sustainable development
Credits	Total: 6 ECTS credits, 216 academic hours M6.1. 3 ECTS credits, 108 academic hours M6.2. 3 ECTS credits, 108 academic hours
Module leader and assistant (if any)	Prof. Sazonov E.V.
Study terms	M6.1. Year 1, semester 1 M6.2. Year 2, semester 3

Aim of the module

The aim of this module is the necessity to introduce to the master students methods of environmental control. Traditional ecological audit, described in the present module, includes technical investigation, analysis of ecological safety and power sustainable development.

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.

Lectures	Semester 1: 36 hours Semester 3: 36 hours
Laboratory works, seminars	Semester 1: 36 hours Semester 3: 36 hours
Individual work	Semester 1: 36 hours Semester 3: 36 hours

Module Learning outcomes

Knowledge and understanding:

- Demonstrate the understanding and adopting the methods of environmental control,
- Analysis of ecological safety and power sustainable development;
- Knowledge in the sphere of energy and environment audit, as well as skills to
- Work with tools for energy and environment processes control

Practical skills

- Organize ecological audit
- Recording/documenting audit results
- Statistical methods of data processing
- Develop recommendations
- Make audit reporting

Graduate (or Transferable) skills

- Ability to implement of power sustainable development issues in engineering practice

Assessment methods

Students' knowledge and understanding are assessed by a variety of methods such as tests, students presentations and examinations.

Module Learning Outcomes	**Contents and/or Educational Activities that contribute to the achievement of the MLO**
The study of the methods of environmental control.	Study public laws in the field of environmental control.
	Study regional legal acts in the field of ecological audit.
The study of tools for energy and environment processes control.	Study energy-saving technologies used for environmental processes control.
The study of statistical methods of data processing.	Study mathematical statistics approaches for energy saving evaluation.
Module Learning Outcomes	**Teaching / learning method and Criteria of Assessment**
The study of the methods of environmental control	lectures
	seminars
	examination
The study of tools for energy and environment processes control	lectures
	seminars
	literature sources study, paper preparation
	examination
The study of statistical methods of data processing	lectures
	seminars
	examination
Module Learning Outcomes	**Course units**
The study of the methods of environmental control	written reports
The study of tools for energy and environment processes control	oral presentations
The study of statistical methods of data processing	written reports

Module 7 Title	**Economic justification of application of energy saving technologies**
Course Titles	M7.1. Methodology of the assessment of efficiency of implementation of energy saving aspects M7.2. Assessment of technologies of increase of power efficiency
Credits	Total: 4 ECTS credits, 144 academic hours M7.1. 2 ECTS credits, 72 academic hours M7.2. 2 ECTS credits, 72 academic hours
Module leader and assistant (if any)	Prof. Semenov V.N.
Study terms	M7.1. Year 2, semester 3 M7.2. Year 2, semester 3

Aim of the module

This module will provide the students with the knowledge of the methodology for the assessment of efficiency ofimplei implementation of energy saving aspects at all stages of the design, construction and maintenance of energy efficient buildings. Economic aspects for the assessment of technologies resulting in the increase of power efficiency will be given.

Lectures	Semester 3: 15 hours
Laboratory works, seminars	Semester 3: 30 hours
Individual work	Semester 3: 99 hours

Module Learning outcomes

Knowledge and understanding:

- Acquire knowledge of methods of productions economic efficiency calculation
- Gain the knowledge of the methodology for the assessment of efficiency of implementation of energy saving aspects at all stages of the design, construction and maintenance of energy efficient buildings

Practical skills

- Skills for the assessment of advanced technologies resulting in the increase of power efficiency
- Assess the quality of the obtained solutions with due account for economic criteria

Graduate (or Transferable) skills

- Skills to make the evaluation of the advanced technologies resulting in the increase of power efficiency and their further utilization in the engineering practice
- Critical estimation of the quality of the obtained solutions based on the advanced economic criteria

Assessment methods Students' knowledge and understanding are assessed by a variety of methods such as tests, students presentations and examinations.	
Module Learning Outcomes	**Contents and/or Educational Activities that contribute to the achievement of the MLO**
The study of state policy and legislation in the field of energy-saving.	Study public laws in the field of energy-saving.
	Study regional legal acts in the field of energy-saving.
The study of efficiency of implementation of energy saving aspects at all stages of the design, construction and maintenance of energy efficient buildings.	Study energy-saving materials in the erection of buildings and structures.
	Study energy-saving technologies in the erection of construction objects.
	Study energy saving in the use of buildings and structures (energy performance certificate, energy performance monitoring).
The study of methods of rational and efficient use of fuel and energy resources.	Study regional fuel and energy resources.
	Study waste energy resources.
	Study utilization of alternative and renewable energy.
Module Learning Outcomes	**Teaching / learning method and Criteria of Assessment**
The study of state policy and legislation in the field of energy-saving	lectures
	seminars
	examination
The study of energy-saving technologies, materials and facilities utilized in the processes of erection and operation of construction objects	lectures
	seminars
	literature sources study, paper preparation
	examination
The study of methods of rational and efficient use of fuel and energy resources	lectures
	seminars
	examination

Module Learning Outcomes	Course units
The study of state policy and legislation in the field of energy-saving	written reports
The study of energy-saving technologies, materials and facilities utilized in the processes of erection and operation of construction objects	oral presentations
The study of methods of rational and efficient use of fuel and energy resources	written reports

Module 8 Title	Approved practical and research experience
Course Titles	Total: 57 ECTS credits, 2052 academic hours M8.1. 6 ECTS credits, 216 academic hours for practice M8.2. 51 ECTS credits, 1836 academic hours for Master Thesis
Module leader and assistant (if any)	Prof. Semenov V.N. and all scientific supervisors
Study terms	M8.1. Year 1, semester 2 M8.2. Year 2, semester 3, Year 2, semester 4

Aim of the module

The module will be carried out in cooperation with a scientific supervisor in industrial organizations / research centres / university laboratories. Students will be inserted into research and practical activities with possible future employment perspective. Students will carry out projects and tasks assigned by the organizations. This experience will give them the opportunity to take initiatives as well as to develop the self-confidence, interpersonal and adaptation skills. Research activities during the creation and fulfilment of their Master thesis will prepare students for future work in research and design institutions dealing with energy saving technologies at all stages of design, construction and maintenance of energy effective buildings and structures.

Learning outcomes

To carry out projects and tasks given by a lead organization during the period of Master's internship. To conduct research-based experimental work, results receiving, accuracy and authenticity proving, review of data, discovering cause-effect relations, determination of research innovative and relevant features. Research results to be included and implemented in master thesis.

Module Learning Outcomes	Contents and/or Educational Activities that contribute to the achievement of the MLO
The ability to conduct experiments as a part of result-oriented research work and to prove the accuracy and validity of the results obtained.	Study and analyze scientific and technical data from domestic and foreign experience in the area of energy efficient heating, ventilation and gas supply systems.
	Be able to set scientific and technical task, to select methodical ways and means of its solution.
	Get mathematical modelling methods of the processes in heating, ventilation and gas supply systems and computer methods for these models realization.

	Get mathematical modelling methods of the processes in heating, ventilation and gas supply systems and computer methods for these models realization.
	Acquire skills to design computational methods and means of automation design.
	Acquire skills to arrange and conduct experiments and to provide metrological assurance.
	Acquire skills to develop and use databases and information technologies for solving scientific, technical and economic problems in the area of energy efficient heating, ventilation and gas supply systems.
The ability to process data, to discover cause-consequence relations, to define the scientific novelty and functional significance of the results, to make scientific and technical report.	Acquire skills to prepare data for making reviews, reports, scientific and other publications.
	Be able to collect, process and analyze the results to identify the theory and experiment.
	Be able to provide the results of the works completed applying modern techniques (reports, papers, thesis, articles, presentations).
The ability to carry out projects and tasks of leading organizations in new conditions and in cooperation with colleagues, to find organizational and administrative decisions in non-typical situations and to bear responsibility for their realization.	Know the influence of psychological factors on the course and quality of an experiment.
	Be able to plan and conduct research independently.
	Be able to organize the application of the results of research and practical formulation.
	Be able to negotiate, make contacts, reconcile conflicts of interests.
Module Learning Outcomes	**Method and Criteria of Assessment**
The ability to conduct experiments as a part of result-oriented research work and to prove the accuracy and validity of the results obtained	design and research works, presentation literature sources review
	report presentation

The ability to process data, to discover cause-consequence relations, to define the scientific novelty and functional significance of the results, to make scientific and technical report	design and research works, presentation literature sources review
	research report presentation
The ability to carry out projects and tasks of leading organizations in new conditions and in cooperation with colleagues, to find organizational and administrative decisions in non-typical situations and to bear responsibility for their realization	design and research works, presentation
	practice research report presentation, advisor's testimonial
Module Learning Outcomes	**Course units**
The ability to conduct experiments as a part of result-oriented research work and to prove the accuracy and validity of the results obtained	paper literature sources review
The ability to process data, to discover cause-consequence relations, to define the scientific novelty and functional significance of the results, to make scientific and technical report	research report
The ability to carry out projects and tasks of leading organizations in new conditions and in cooperation with colleagues, to find organizational and administrative decisions in non-typical situations and to bear responsibility for their realization	practice report

Module 9 Title	Total state certification. Defence of Master thesis
Credits	3 ECTS credits, 108 academic hours
Module leader and assistant (if any)	All scientific advisors
Study terms	Year 2, semester 4
Aim of the module To prepare Master Thesis according to all requirements	
Learning outcomes Preparation of the Master's thesis and passing final State examination. Valuable practical results of the Master thesis and their application for the regional economy and the socioeconomic environment.	

Module Learning Outcomes	Contents and/or Educational Activities that contribute to the achievement of the MLO
The development of an original theme based on independent research and related to the development of energy-efficient heating, ventilation and air conditioning systems in buildings	study literature sources
	conduct experiment
	compute (mathematical modelling)
	present thesis
Module Learning Outcomes	**Method and Criteria of Assessment**
The development of an original theme based on independent research and related to the development of energy-efficient heating, ventilation and air conditioning systems in buildings	independent study of literature sources
	design and research work
	public defense of master's thesis in State Examination Board
Module Learning Outcomes	**Course units**
The development of an original theme based on independent research and related to the development of energy-efficient heating, ventilation and air conditioning systems in buildings	Master thesis

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
- Field 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
- Accreditation of the programme by the Academic Council of Voronezh State University of Architecture and Civil Engineering
- Ministry of Education and Science of the Russian Federation official recognition (licensing)
- Evaluation by employers

Employment opportunities

Civil Engineering research and design institutions, Government and private construction enterprises, Municipal and Communal Service, Research and Quality Control Processes; Public Administration related to environmental protection; institutions and enterprises applying energy saving and 'Green construction' technologies. Graduates can work as industrial consultants for environmental protection.

Learning resources

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

Educational laboratory equipment set "The device, work and the account in systems of heating of the building" (LS/PO-URUSOZ)

The laboratory complex acquaints students with the main instrumentations used in systems of water supply and heating, the principles of their work and possibility of application, definition of performance data of elements of systems of heating.

The laboratory stand ''The Device, Work and the Account in Systems of Heating of the Building'' of floor execution represents the operating closed hydraulic system with the established samples of sensors which are applied in monitoring systems and the accounting of a consumption of water, pressure and water temperature control on objects of housing and communal services, and radiators of water heating. The system of pipelines and spherical cranes allows to model necessary for performance of laboratory works a configuration of system of heating.

The laboratory stand is intended for acquaintance of students with the main instrumentations used in systems of water supply and heating, studying of the principles of their work and possibility of application, definition of performance data of elements of systems of heating.

The personal computer is intended for management of operation of the stand as a whole, namely: operation of the pump, the electric boiler, spherical cranes with the electric drive.

In the package of delivery is included the electrified training module with training indication. The training module represents the interactive light-dynamic touch panel, allowing one to provide training and software testing to check of the acquired material. The marker touch surface allows one to bring adjustments in training process. The established software ''The virtual teacher'', allows to provide group training. The module is the tool of the teacher allowing him/her to present a material on safety measures during the work with educational laboratory equipment in the sphere of housing and communal services.

Recommended literature

1. Kishimoto A. Advanced Energy Saving and its Applications in Industry, 2013. – 75 p.
2. Li Xianguo Green Energy. Basic Concepts and Fundamentals, 2011. – 288 p.
3. Magrini A. Building Refurbishment for Energy Performance, 2014.– 252 p.
4. Hakansson A. Sustainability in Energy and Buildings / Proceedings of the 4th International Conference in Sustainability in Energy and Buildings (SEB´12), 2013. – 554 p.
5. Howlett Robert J. Sustainability in Energy and Buildings/ Results of the Second International Conference in Sustainability in Energy and Buildings (SEB'10), 2011. – 302 p.
6. M'Sirdi N. Sustainability in Energy and Buildings / Proceedings of the 3rd International Conference on Sustainability in Energy and Buildings (SEB´11), 2012. – 650 p.
7. Lee Shaun H. Sustainability in Energy and Buildings / Proceedings of the International Conference in Sustainability in Energy and Buildings (SEB'09), 2010.
8. Ziębik A. Energy Systems of Complex Buildings, 2013. – 345 p.
9. Zamfirescu C. Sustainable Energy Systems and Applications, 2012. – 816 p.
10. Geller G. Sustainable Rural and Urban Ecosystems: Design, Implementation and Operation. Manual for Practice and Study, 2012. – 179 p.
11. Rassia Stamatina Th. Sustainable Environmental Design in Architecture. Impacts on Health, 2012. – 338 p.
12. Rassia Stamatina Th. Cities for Smart Environmental and Energy Futures Impacts on Architecture and Technology, 2014. – 301 p.
13. Ortigueira, Manuel Duarte Fractional Calculus for Scientists and Engineers, 2011. – 154 p.
14. Lizárraga-Celaya C. Maple and Mathematica. A Problem Solving Approach for Mathematics, 2nd ed., 2009. – 484 p.
15. Wagon St. Mathematica® in Action. Problem Solving Through Visualization and Computation, 3rd ed., 2010. – 574 p.
16. Borwein Jonathan M. An Introduction to Modern Mathematical Computing With Mathematica®, 2012. – 224 p.
17. Sibikin, M. Sibikin. Alternatives and Renewables energy sources, 2012.

18. V.I. Vissarionov, G.V. Deriugina etc. Solar energy, 2011.
19. A.B. Alhasov. Renewable power generation, 2010.
20. O.D. Samarin. Thermo-physical and technical-economic foundations of Thermal Engineering safety and energy efficiency in buildings, 2007.
21. A.N. Dmitriev, Y.A. Tabunshikov etc. Manual on estimation of economical efficiency of investment in energy-efficiency, 2010.
22. I.M. Kvashnin. Emission limited values of plants into the atmosphere. Dispersion and establishment of standards. 2011.
23. M.M.Brodach. Industrial emission into the atmosphere. Engineering analyses and inventory, 2011.
24. Y.A. Tabushnikov, M.M. Borodach. Mathematical modeling and optimization of buildings' thermal effectiveness, 2012.
25. V.N. Karpov. Hot water heating systems of multi-storey buildings. Technical guidelines for the design, 2012 Instruction on the calculation of heat loss in rooms and thermal loads on the heating of residential and public buildings, 2012.
26. New English-Russian, Russian-English dictionary of technical terms and phrases for Heating, Ventilation , Air-Conditioning , and Thermal Physics, 2011.
27. M.M. Brodach. Engineering equipment of high-rise buildings, 2011.
28. Technical guideline on the organization of ventilation in the apartments of residential buildings, 2011.
29. V.M.Magadeev. Sources of heat supply system, 2013.
30. A.Salihov. Unvalued and unrecognized ''small'' energy, 2009.

Curriculum map for Master Study-Programme in Innovative Technologies for Energy Saving and Environmental Protection, «Green Master»

Module	A 1	A 2	A 3	A 4	A 5	A 6	A 7	B 1	B 2	B 3	B 4	B 5	B 6	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8
M1. Theoretical bases of scientific research		x	x	x				x	x	x				x	x	x	x			x	
M2. Mathematical analysis and modeling of power effective systems	x	x	x			x	x	x	x	x	x	x	x	x		x	x	x		x	x
M3. Standards of energy saving ensuring and increase of power efficiency	x	x	x	x			x	x	x		x		x	x	x		x				x
M4. Methodology of energy saving and increase of energy efficiency	x	x	x	x	x		x	x	x	x	x		x	x	x		x	x		x	
M5. Theory and practice of increase of energy efficiency		x	x	x		x	x	x	x	x	x	x		x	x		x	x	x	x	
M6. Environmental problems of energy saving and ways of their decision	x	x		x	x		x	x	x	x	x		x	x	x		x	x		x	x
M7. Economic justification of application of energy saving technologies			x	x			x	x				x	x	x	x	x			x	x	
M8. Scientific and research work in semester Research and pedagogical practice								x	x	x	x	x	x	x	x	x	x	x	x	x	x
M9. Master Thesis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Programme learning outcomes

Knowledge and understanding	
A1	Fundamental knowledge and understanding of innovative technologies in energy saving and environmental control
A2	Understanding of optimization approach and methods of energy and resource saving processes
A3	Understanding of energy saving as the basis of green technologies development
A4	Knowledge of administrative authorities and legislation in the field of environment protection
A5	In-depth knowledge of design, construction and maintenance of energy efficient Buildings and energy saving technologies
A6	Knowledge of mathematical and analytical concepts and models for solving energy. Saving problems on all stages of design, construction and maintenance of energy efficient buildings .
A7	Critical evaluation of current methods of energy production and utilization
Practical skills	
B1	Ability to provide technical and managerial input into planning of energy and resource saving projects an facilities (in native language and in English)
B2	Ability to solve engineering problems through the application of theoretical concepts and practical knowledge in industrial environment
B3	Ability to carry out laboratory and field experiments, collect, analyse and interpret data
B4	Select and use appropriate methods and technologies for energy and resource saving
B5	Use appropriate information technology for engineering and management purposes
B6	Ability to design the energy effective buildings
Graduate skills	
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)
C2	Identify and use various learning sources in students' scientific occupations
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)

C4	Make informed professional decisions based on scientific knowledge and appropriate criteria
C6	Develop efficient time management skills
C7	Appreciate the social impact of research and practical work in the field of study
C8	Reflect and evaluate on own learning and evaluate peers in a professional manner

Didactic programme materials

The textbooks series has been developed and printed specially for the new programme in cooperation of the Russian and European teachers. It consists of 9 textbooks and the Glossary of the project.

	Textbook title	**Book Editor**
1.	D. Mendeleev University of Chemical Technology of Russia	
	Green technologies for sustainable development	N. Tarasova
2.	Tambov State Technical University	
	Energy efficiency improvement in natural and industrial systems	N. Popov
3.	Genoa University	
	Basis of thermodynamics and exergy analysis	L. Tagliafico
4.	Ural Federal University n.a. Boris Yeltsin	
	Lifecycle of energy, energy management and optimum decision making	N. Shiryaeva
5.	Tambov State Technical University	
	Energy and environmental audit	N. Popov
6.	Russian Academy of Architecture and Construction Sciences	
	Engineering and economic analysis of energy saving activities	S. Fedosov
7.	Stavropol State Agrarian University	
	Environmental safety and energy sustainable development	N. Kornilov
8.	Voronezh State University of Architecture and Civil Engineering	
	Practical application of energy saving technologies	V. Semenov
9.	Vladimir State University n.a. Stoletovs	
	Modelling technological and natural systems	Y. Panov
10.	Genoa University and Tambov State Technical University	
	Glossary for GREENMA project	A. Musaio L. Mozerova

Tests for summing up modules

Program-aided methods for increasing the energy effectiveness

- How are the volumes of produced energy and heat distributed for generation sources?
- Give approximate number of fuel and oil resources stock. Describe recourses consumption system in 21st century.
- What does Russian economy contain as energy systems saving reserves (%)?
- How are water resources distributed in industries?
- How do industry and transport affect the atmosphere condition?
- How does energy saving influence on emissions reduction?
- What are the main energy resources saving methods at industries and everyday life?
- What state bodies control energy saving?
- Name the main fields of energy saving state policy.
- Does energy saving require business development?
- How is energy saving programme implemented in regions?
- What kind of organizations of the Voronezh region are interested in energy saving programmes realization?

“Green construction” for a sustainable development of territories

- What are the tasks in “Energetic programme of Russia till 2020”?
- Enumerate main activities for energy saving.
- What tools are applied for commercial measurement of power consumption?
- Give the definition of two-winding electrical transformers.
- What is the influence of active and reactive power correlation on energy losses in energy saving systems?
- Define the principle of electric motor reactive power compensation and related applied devices.
- What are the technical means of reactive power compensation?
- What are the components of electric motor total loss?
- How does motor controller load influence on its energy efficiency conversion and when do we manage the electrical motors change?
- Name general activities for energy saving of electrical motors exploitation.
- Life cycle of energy, energy management and optimal decision making

Life cycle of energy resources and real estate objects

- What are the components of energy consumption balance?
- What is the purpose of enterprise energy balance?
- What forms income and expenditure sides of active power energy balance?

Power balance and energy audit

- What do power costs at enterprise and housing and utility sector define? Give examples.
- What factors define energy efficiency of water supply and water consumption systems?
- What energy saving reserves can be applied in water supply of industries and residential buildings?
- What energy saving reserves can be applied in drainage?
- What is the role of water supply and drainage systems automatization for energy saving?
- Evaluate the reasons of power overspend in water supply and drainage systems.
- How are power saving volumes evaluated in water supply and drainage systems?

Methods of the solution of scientific and engineering tasks in civil engineering dealing with energy saving and efficiency

- What is the role of individual water control of consumer?
- What is the purpose of energetic examination of boilers and ancillary equipment?
- What necessary certification does boiler plant equipment require?
- What does equipment and widget certification at thermal engineering mean?
- Explain the influence of air on fuel losses at boilers.
- What is chemical unburned fuel? Its influence on boilers economy.
- Explain the function of economizers and direct contact heat exchangers at boiler plant.
- Give examples of energy saving activities and their efficiency during boiler plant work.
- What is the role of water purification for heat and power equipment?
- What is the purpose of deaeration of boilers and heat systems make up water?

Practical recommendations concerning the application of energy saving technologies

- Name modern technologies of water preparation.
- What are the complexones and how do they remove limescale from heating systems?
- Name the types of deaeration devices of make up water and their operation cycle.
- What are the areas for technological processes analysis calculation?
- Assess the efficiency of specific activities for energy saving in district heating systems.
- Give definition of “building heat shield” term.

- Name the rates of building heat shield.
- What are the classes of building energy efficiency according to standards of 23.02-2003.
- What are the normalized values of thermal resistance?
- Name the energy saving reserves of housing construction.
- Name the energy saving reserves of housing heating.
- How can steam boiler plants energetic potential be applied?
- What are the energy losses of consumers heating substations?
- Name heating consumption control devices.
- What is the meaning of regulation of heating delivery and consumption?

Life cycle of energy resources and real estate objects

- What are the components of heat consumption balance?
- What is the purpose of enterprise heat balance?
- What forms heat energy expenditure sides of housing and utility sector enterprises?
- Name the main energy losses types of compressor installations.
- What is the influence of compressed air pressure on its leaks through holes and power losses?
- How to economize the energy during compressor exploitation?
- How do you understand heat and chemical pollution of atmosphere?
- What are the blow air conditioners and their function in boiler's operation?
- Name other application of steam at steam boiler plants.
- What does the heat and power cogeneration mean in heating system and is it possible to apply it at steam boiler plants?

Ecological assessment and audit

- What are the main legal documents of energy and environment audit?
- What organizations can conduct the energy and environment audit?
- What are the purposes and tasks of energy and environment audit?
- What are the main stages of energy and environment audit?
- Name the motivations of individual control of energy recourses for population.
- Name requirements for devices applying at energetic inspection.
- Define the application of technical and economic analysis.
- What does building energy and ecology certificate involve?
- What does onsite energy loss elimination programme involve?
- Name the assessment of investment efficiency for enterprise energy saving programme.

Laboratory works №1-7

Laboratory works №1-7 are developed for the following modules:

- Green construction» for a sustainable development of territories
- Methods of the solution of scientific and engineering tasks in civil engineering dealing with energy saving and efficiency
- Power balance and energy audit

Laboratory works are conducted with help of special stands providing alternative energy sources application: solar collectors, heat pumps and wind generators.

Textbooks for laboratory works contain the following materials:

Solar collectors, their constructions and purpose working principles.

Practices with solar collector: operating mode choice, energy conversion efficiency estimation.

Wind turbine installation capability study, construction features analysis, application in Russia. Definition of optimal operating regimes of wind generator in Russia.

Study of heat pump construction.

Calculation of pump heating load at household.

Heat pump stand practice.

Laboratory work defense is conducted with the help of results demonstration at stands.

Requirements for laboratory work acceptance

Work is “defended” if:

a) It is organized according to department’s requirements. Master student can work with stands and answers 90% of teacher’s questions.

Teaching methods in GREENMA programme

Various teaching methods are being used in the frames of GREENMA.

a) Laboratory method when the students study equipment, its application and study variants of equipment application in different climate conditions. The reports and analysis are made based on the results of lab works.
b) Research method encouraging students' creative activity by setting new tasks and problems. Students use INTERNET search tools and conduct patent search.
c) Active study directed on obtaining skills of energy saving technology and methods. Realized during stage and practical study at enterprises.
d) Problem solution method is used at the final phase of study when the topic of master thesis is chosen.

Active study in GREENMA programme

The programme supports the individual work of master student provided by individual choice of thesis theme, individual Internet search of literature, personal tasks organization, self-education skills development. Among the enumerated technologies a special attention is given to case-studies.

VSUACE study programme involves two types of case-studies:

a) analysis and assessment of energy saving problem teaching;
b) decision-making teaching.

One of the examples of case-studies application in "Improvement of energy efficiency in civil and industrial buildings" is the task of energy saving during the stages of design, construction and maintenance of buildings. Its solution is conducted gradually. In the beginning of each stage a teacher defines the aim of master students work. At the end of stage its success/fail is demonstrated. It is useful both for individual work and team work.

Different assessment criteria

Assessment criteria for test results

a) competence assessment criteria (results)

Test questions show the comprehension level of students' knowledge, skills and abilities according to competences. Credit test includes different tasks allowing assessment of competence acquisition for:

- determination of technical concepts;
- energy saving processes characteristics;
- equipment efficiency factors characteristics;
- appropriate judgement choice.

Students should answer the questions of credit (examination) test in the expected time, choosing one of four given answers. The results of discipline sections are checked separately.

b) description of assessment scale

- Up to 40 % of right answers – competences are not acquired, test repeating;
- 40–60 % of right answers – partial acquisition of competences, extra questions for subject sections if low grades;
- 60–80 % of right answers – sufficient level of competence acquisition;
- More than 80 % of right answers – high level of competence acquisition

Assessment criteria	**Assessment scale**
Assessment scale Test results 60–80% – knowledge of subject is shown, answers to the main questions are right	‘‘passed’’
Test is not completed or result is less 60% – knowledge is poor, answers to extra questions are with essential mistakes	‘‘failed’’

Exam assessment criteria

Assessment criteria	**Assessment scale**
Full answer is given, comprehended knowledge is shown, main issues are disclosed, task is solved	‘‘excellent’’
Answer is logically structured, applying modern technical terms, some inaccuracies or small mistakes are made	‘‘good’’

Answer is insufficient, logic is broken, task is not solved or serious mistakes are made	‘‘satisfactory’’
1. The answer is vague with significant mistakes 2. No answer 3. Reject to answer	‘‘unsatisfactory’’

Procedure of preliminary review of graduation qualification work (thesis)

Prepared and organized graduation qualification work (GQW) passes the procedure of preliminary review at commission meeting. Commission consists of head of department, person in charge of MSP of HE, SEC members (staff of VSUACE), GQW managers. Commission members are approved by department’s head order, responsible for MSP of HE. GQW pre-consideration Commission meeting is held one week before SEC meeting. The dates of both meetings are appointed and brought to students’ attention at the same time.

Following materials are provided for GQW pre-consideration Commission meeting:

- GQW got compliance assessment, checked for plagiarism and organized according to СТП VSUACE 07-97 “Diploma and course projects (works). Registration rules” and recommendations for graduation works fulfillment in e-form, confirmed by VSUACE rector’s order dated 14.05.2010, № 125-04 (provided to students);
- Review of GQW supervisor (presented by GQW supervisor);
- GQW check results for plagiarism (presented by GQW supervisor);
- Student’s academic record book (presented by SEC secretary).
- GQW preliminary review Commission:
- Evaluates student’s readiness for GQW defense;
- Checks the full set of materials for GQW defense;
- Gives results of competences level, based on current grades of student (for students FSES HVE or FSES HE);
- Based on GQW check results for plagiarism, concludes about the requirement fulfillment for GQW borrowing;
- Forms and gives results to student about level of general and professional competences and GQW defense permit (for students FSES HVE or FSES HE) or GQW defense permit (for students FSES).

GQW defence procedure

SEC meetings for GQW defence are held according to time schedule of study process, considering:

- One meeting period is no more than 6 hours;
- During one meeting no more than 12 GQW can be defended;
- Only 30 minutes for student’s GQW defence.

GQW defence includes student's report (10 minutes) with presentation, analysis of supervisor's comments and reviews, commission questions, student's answers. It can also include reviewer's and GQW supervisor's presentations.

SEC meeting is minuted by secretary and signed by all SEC.

Assessment for GQW presentation and defence and qualification awarding are preceded during SEC private meeting after all appointed works defence. The decision is made by majority of votes.

SEC decision about GQW grade, "Master" qualification award in 270800 – "Civil Engineering" is announced to graduates in the same day after private meeting.

Assessment criteria for GQW accomplishment and defence

Discussion and final assessment of GQW defence is completed at SEC private meeting, defining the grade – "excellent", "good", "satisfactory", "unsatisfactory". Each student's answer is evaluated according to score system, considering the minutes, proceeded by SEC secretary.

The student's answer is evaluated by score summing up. Total score of SEC member is defined as average grade comprising student's report, student's answer for each extra question and for participation in discussion, ability to give arguments and take a stand, 66 considering SEC members' views. Final assessment is determined according to average score of each member grades:

- Grade "2" – "unsatisfactory";
- Grade "3" – "satisfactory";
- Grade "4" – "good";
- Grade "5" – "excellent".

Grade **"excellent"** is given if the following conditions are fulfilled:

- GQW meets FSES requirements;
- GQW fully corresponds to the theme, contains given task solution;
- theoretical and practical parts are correlated;
- based on source study, the thesis presents individual analysis of real material;
- thesis presents individual conclusions of student, student demonstrates knowledge of material, confidently answers most questions;
- thesis is presented in time, with full reviews and supporting documents.

Grade **"good"** is given if the thesis is completed and defended in the following way:

- work is acceptable but has some shortcomings in respect of FSES;
- exposition of the topic is insufficient, some questions are not answered;
- theoretical and practical parts are correlated enough;
- graduate uses material soundly, but doesn't answer all questions adequately;
- graduate needs supervision during material and source analysis;
- thesis is presented in time, with full reviews and supporting documents.

Grade **"satisfactory"** is awarded if the thesis is completed and defended in the following way:

- work is acceptable but has shortcomings in respect of FSES;
- exposition of the topic is not clear enough, the work doesn't provide clear answers for all questions (many misunderstandings);
- number of learning resources is less than 30;
- material and learning resources individual analysis is not provided;
- graduate doesn't demonstrate sufficient knowledge of theoretical approaches for problem solving and correlated works of leading scientists;
- thesis defence is uncertain, commission members are not satisfied with answers;
- thesis is presented after registration date of GQW, the thesis content has significant shortcomings.

Grade **"unsatisfactory"** is awarded if the thesis is completed and defended in the following way:

- work is presented after registration date of GQW, the thesis content has significant shortcomings;
- review is not provided;
- work doesn't meet FSES requirements;
- graduate can't provide support facts to theoretical statements;
- graduate doesn't know learning resources;
- conclusions are not logically and clearly presented, graduate doesn't answer questions;
- proposals are not made for subsequent research, decision-making and conclusions are not provided;
- thesis has large abstracts of plagiarism without references.

If the votes for grade awarding are divided equally, the Head of SEC is responsible for final decision.

The GQW results are available for students after private SEC meeting.

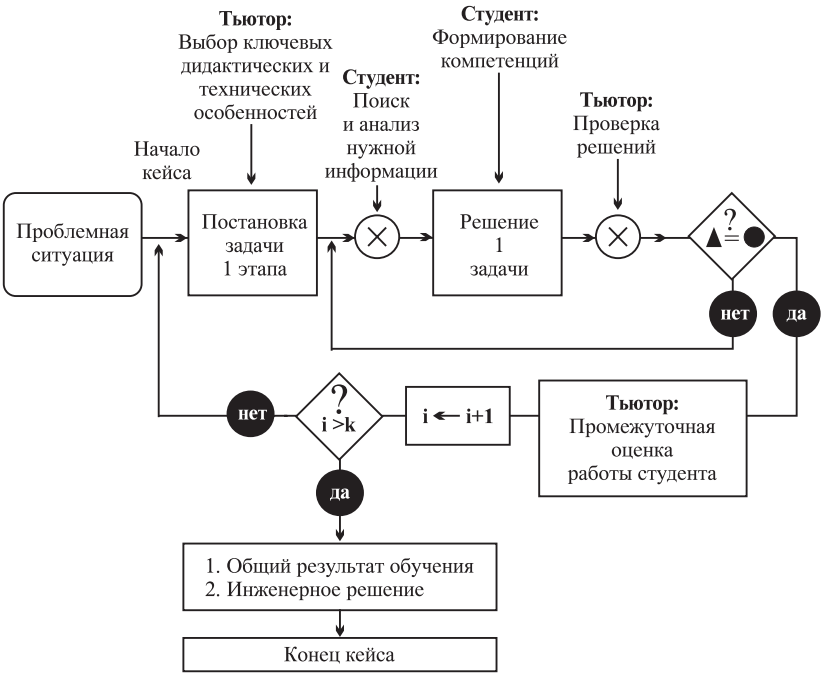
If the student fails thesis defense, a new examination is offered according to the order of Vice-rector for educational activities after thesis revision.

SEC Head and secretary prepare GQW defence report, which is approved at the department meeting.

Метод Case-Study в программе Green Master

Примеры использования метода кейсов

Программная карта кейса (алгоритм обучения)



Module M4.3 “The main trends of energy saving at design, construction and maintenance of buildings”

Case Study No.1 “Исследование влияния формы и размеров здания на снижение теплопотерь”

1.1.Теоретические основы влияния формы здания на снижение теплопотерь

Для определения теплопотерь через наружные ограждающие важно соотнести их величину с размерами здания.

При разработке объёмно-планировочного решения здания выбор основных размеров – длины, ширины, высоты – следует осуществлять в зависимости не только от назначения здания, но и от того, какую общую площадь наружной поверхности будет иметь сооружение данной формы. При этом следует учитывать, что здание равного объёма и одинакового конструктивного решения может иметь разные размеры (пролёт, длина, высота), а следовательно, разные площади их наружной поверхности и неодинаковую величину теплопотерь.

Три здания: одно кубической формы, а два других – в форме параллелепипеда. Все три здания имеют один и тот же объём, но разную площадь наружной поверхности.

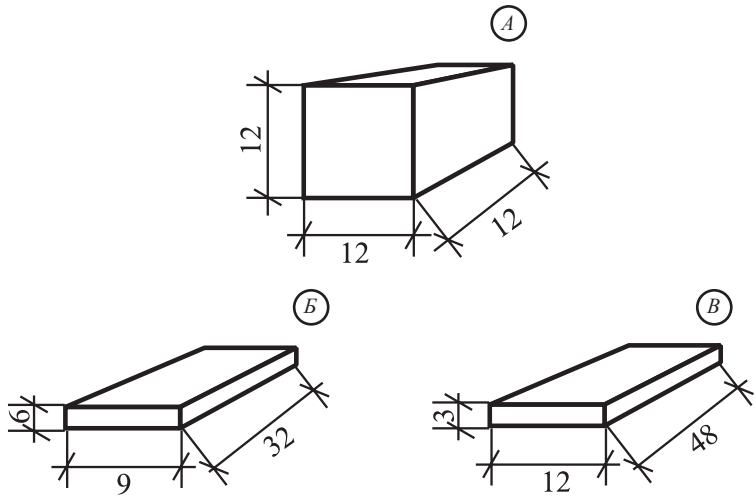


Рис.1. Формы зданий одного и того же объёма:
а) – куб ; б, в) – параллелепипеды

Меньшее значение S/v имеет здание в форме куба

Таблица: «Значение S/v в зависимости от размеров объектов»

Форма здания	S	V	S/V
Куб	864	1728	0,5
Параллелепипед	1068	1728	0,618
Параллелепипед	1512	1728	0,875

Sнп/v – площадь наружной поверхности

Следовательно, здание-куб наименее материалоёмко, наиболее экономично и отличается наименьшими теплопотерями.

Приняв за эталон компактного решения здание кубической формы, можно дать сравнительную оценку зданиям другой формы, но с тем же объёмом отношения:

$$f=(S/v)зд. / (S/v)эт.$$

показывает, во сколько раз сравниваемое здание менее компактно, чем здание эталон. Т.к. объёмы зданий равны, то:

$$f=(S)зд. / (S)эт.$$

Определив это отношение для зданий, получим, что здания 2 и 3 менее компактны, чем здание – эталон соответственно в 1.236 и 1.75 раза.

1.2. Теоретические основы исследования влияния размеров здания на его теплопотери

Наибольший эффект в экономии энергоресурсов здания связан с шириной здания.

Энергоэкономичность объёмно-планировочного решения можно оценить с помощью отношения величины теплопотерь здания и его полезной площади – удельного расхода тепла.

С увеличением ширины корпуса с 12 м до 18 м удельный расход тепла и приведённые затраты снижаются на 18 и 14,6% (соответственно), т.е. технико–экономическая эффективность повышается с увеличением ширины здания.

Теплопотери снижаются с ростом этажности здания. В условиях суровых зим (-26…-60^{o}C) изменение этажности административного здания от 1 до 3 этажей снижает удельные теплопотери 28…32%. Увеличение этажности 3 до 12 этажей снижает теплопотери на 1…2%.

Снижение теплопотерь в зданиях высокой этажности (12 этажей и более) применимо только при надёжной герметизации наружных ограждающих

конструкциях.

Для достижения экономии тепловой энергии необходимо сократить площадь наружных ограждений. С этой целью проектируют многоэтажные здания, имеющие большую площадь в плане.

1.3. Определение оптимальных размеров здания по минимуму теплопотерь

Район строительства – РФ г. Воронеж

Исходные данные:

- Коэффициент остекления фасада здания $f=0,56$ $м^{2\cdot o}C/Вт$
- Сопротивление теплопередаче:
  стен $R_{ст}=2,975$ $м^{2\cdot o}C/Вт$
  - окон $R_{ок}=0,4875$ $м^{2\cdot o}C/Вт$
  - покрытия $R_{пок}=4,45$ $м^{2\cdot o}C/Вт$
  - перекрытия подвала $R_{цок}=3,925$ $м^{2\cdot o}C/Вт$
- Наружный объём здания: $V= 40\ 000$ $м^3$
- Высота этажа $h=3$ $м$
- Ширина здания $A=15$ $м$

Решение:

Средний коэффициент теплопередачи теплотехнически неоднородных вертикальных ограждений $k_{верт}$, $Вт/(м^2\cdot{}^\circ C)$

$$k_{верт}= k_{верт}+f\cdot(k_{ок}-k_{ст})$$

где f – коэффициент остекления,
$k_{ст}$ – коэффициент теплопередачи стены, $Вт/(м^2\cdot{}^\circ C)$,
$k_{ок}$ – коэффициент теплопередачи окна, $Вт/(м^2\cdot{}^\circ C)$,

$$k_{верт}=0.3361+0.56\cdot(2.0513-0.3361)=1.2966\ Вт/(м^2\cdot{}^\circ C)$$

Средний коэффициент теплопередачи теплотехнически неоднородных горизонтальных ограждений $K_{гориз}$, $Вт/(м^2\cdot{}^\circ C)$

$$k_{гориз}=\psi_1\cdot k_{пок}+\psi_2\cdot k_{цок}$$

где ψ_1, ψ_2 – понижающие коэффициенты, равные соответственно 0,9 и 0,6;
$k_{пок}$ – коэффициент теплопередачи потолка, $Вт/(м^2\cdot{}^\circ C)$;
$k_{цок}$ – коэффициент теплопередачи пола, $Вт/(м^2\cdot{}^\circ C)$.

$$k_{гориз}=0,9\cdot0,2247+0,6\cdot0,255=Вт/(м^2\cdot{}^\circ C)$$

Удельные теплопотери здания

$$q_{гориз} = \frac{P}{S} \cdot k_{верт} + \frac{1}{H} \cdot k_{гориз}$$

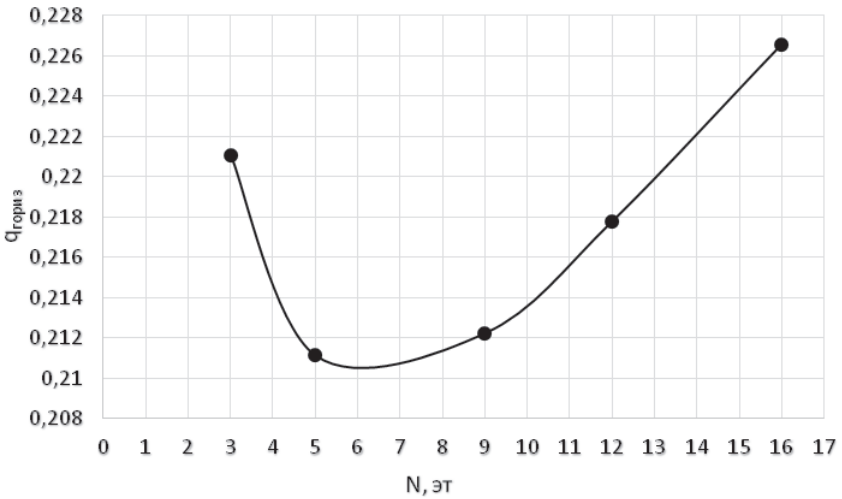
где P – периметр здания, *м*,
S – площадь здания в плане, $м^2$,
H – высота здания, *м*.

Таблица 1.1: «Расчёт удельных теплопотерь здания строительным объёмом 40 000 $м^3$ для различной этажности»

Этажность, N	Высота H, м	Ширина A, м	Площадь S, м2	Длина B, м	Периметр P, м	P/S, 1/м	1/H, 1/м	$q_{гориз}$ $\frac{Вт}{м^2 \cdot °C}$
3	9	15	4440	296	622	0,140	0,111	0,221
5	15	15	2670	178	386	0,145	0,067	0,211
9	27	15	1485	99	228	0,154	0,037	0,212
12	36	15	1110	74	178	0,160	0,028	0,218
16	48	15	840	56	142	0,169	0,021	0,227

По результатам расчётов строим график.

График 1: «График зависимости удельных теплопотерь здания от этажности при объёме здания V=40 000 $м^3$.»



Вывод:

На основе расчетов можно сделать вывод, что пятиэтажное здание с шириной и высотой равной 15м наименее материалоёмко, наиболее экономично и отличается наименьшими теплопотерями.

Что делает тьютор?	**Что делает студент?**	**Что делают совместно?**
1. Ставит задачу определить оптимальные размеры здания по минимуму теплопотерь. 2. Знакомит с теоретическим основами исследования влияния размеров здания на его теплопотери. 3. Рекомендует вспомогательную литературу. 4. Задает компетенции для данной дисциплины.	1. Осуществляет поиск необходимой информации для решения задачи по определению оптимального размера здания. 2. Анализирует и обрабатывает информацию по расположению здания, материалов ограждающих конструкций и их свойств. 3. Выполняет расчет удельных теплопотерь исходя из строительного объема здания. 4. Делает основные выводы по выполненной работе.	1. Обсуждают презентации студентов. 2. Формируют замечания по расчету и ходу работы. 3. Участвуют в проведении опроса по формированию компетенций. 4. Получают итоговую оценку.

Module M4.3 “The main trends of energy saving at design, construction and maintenance of buildings”

Case Study No.2 “Оценка экономической целесообразности применения энергосберегающей светодиодной лампы освещения вместо лампы накаливания”

2.1. Теоретические основы для оценки экономической целесообразности применения энергосберегающей светодиодной лампы освещения вместо лампы накаливания

Светодиод – полупроводниковый прибор с электронно-дырочным переходом, содержащий оптическое излучение при пропускании через него электрического тока в прямом направлении.

Светодиодные лампы или светодиодные светильники в качестве источника света используют светодиоды, применяются для бытового, промышленного и уличного освещения. Светодиодная лампа является одним из самых экологически чистых источников света. Принцип свечения светодиодов позволяет применять в производстве и работе самой лампы безопасные компоненты.

Светодиодный светильник – светильник, состоящий из корпуса, светодиодного источника света и электронного драйвера (преобразователя питания).

Преимущество светодиодного светильника по сравнению с лампами накаливания

- низкое энергопотребление,
- заявленный долгий срок службы от 30’000 до 50’000 и более часов,
- простота установки,
- более низкая температура корпуса по сравнению с лампой накаливания, имеющей сравнимую яркость,
- высокая механическая прочность,
- зачастую небольшие габариты.
- полная экологическая безопасность позволяет сохранять окружающую среду, не требуя специальных условий по утилизации: не содержит ртути, её производных и других ядовитых, вредных или опасных составляющих материалов и веществ.

Основные недостатки — высокая цена, многие светодиодные лампы светят только в одном направлении (что может быть и достоинством). В дешевых лампах за счет экономии на конденсаторах возникает невидимое невооруженному глазу высокочастотное мерцание, а из-за экономии на теплоотводящих элементах перегорание от перегрева, особенно в закрытых плафонах. Кроме того, при выходе из строя любого из элементов светильник

чаще всего подлежит замене на аналогичный. Эти недостатки чаще всего компенсируются экономией электроэнергии, экономией на обслуживании (замене ламп), что особенно актуально для уличного освещения.

2.2. Обоснование экономической целесообразности применения энергосберегающей светодиодной лампы освещения вместо лампы накаливания.

Исходные данные:

- Потребляемая мощность
- NH = 90 Вт
  NH – потребляемая мощность лампы накаливания, Вт
- $N_Э$= $NH/9$=10 Вт
  $N_Э$ – потребляемая мощность энергосберегающая лампа, Вт
- $S_{Э.Э.}$ = 3,23 руб/Квт·ч
  $S_{Э.Э.}$ – тариф на электрическую энергию, руб/Квт·ч,
- $t_р$= 10 ч/сут.
  $t_р$ – среднее время работы освещения, ч/сут,
- $K_Н$ =13,50 руб
  $K_Н$ – стоимость лампы накаливания, руб,
- $K_Э$=320 руб.
  $K_Э$ – стоимость энергосберегающей лампы, руб.

Решение:

1. Стоимость сэкономленной электроэнергии за 1 час работы освещения, руб/ч

$$\Delta S_ч = (N_н - N_э) \cdot 10^{-3} \cdot S_{э.э},$$

2. Количество часов работы освещения, за которое окупится энергосберегающая лампа, час,

$$t_{ок} = \frac{K_э - K_н}{\Delta S_ч}$$

3. Годовые эксплуатационные затраты на освещение, руб/год определяется по формуле

   3.1 Для ламп накаливания

$$Э_{год\ н} = N \cdot 10^{-3} \cdot t_р \cdot 365 \cdot S_{э.э},$$

3.2 Для энергосберегающих ламп

$$Э_{год\ н} = 90 \cdot 10 – 3 \cdot 10 \cdot 365 \cdot 3{,}23 = 1061{,}06\ руб/год$$

$$Э_{год\ э} = N \cdot 10^{-3} \cdot t_р \cdot 365 \cdot S_{э.э}$$

$$Э_{год\ н} = 9 \cdot 10 – 3 \cdot 10 \cdot 365 \cdot 3{,}23 = 106{,}11\ руб/год$$

4. Годовая экономия определяется, руб,
5.

$$\Delta Э_{год} = Э_{год\ н} – Э_{год\ э}$$

$$\Delta Э_{год} = 1061{,}06 – 1106{,}11 = 954{,}95\ руб.$$

6. Срок окупаемости, год, при среднесуточном времени работы освещения t = 10 ч/сут.

$$T_{ок} = \frac{K_э – K_н}{\Delta Э_{год}}$$

$$T_{ок} = (320 – 13{,}50) / 954{,}95 = 0{,}31\ лет = 4\ месяца$$

Вывод:

На основе расчетов можно сделать вывод, что пятиэтажное здание с шириной и высотой равной 15м наименее материалоёмко, наиболее экономично и отличается наименьшими теплопотерями.

Что делает тьютор?	**Что делает студент?**	**Что делают совместно?**
1. Ставит задачу определить оптимальные размеры здания по минимуму теплопотерь. 2. Знакомит с теоретическим основами исследования влияния размеров здания на его теплопотери. 3. Рекомендует вспомогательную литературу.	1. Осуществляет поиск необходимой информации для решения задачи по определению оптимального размера здания. 2. Анализирует и обрабатывает информацию по расположению здания, материалов ограждающих конструкций и их свойств.	1. Обсуждают презентации студентов. 2. Формируют замечания по расчету и ходу работы. 3. Участвуют в проведении опроса по формированию компетенций. 4. Получают итоговую оценку.

4. Задает компетенции для данной дисциплины.	3. Выполняет расчет удельных теплопотерь исходя из строительного объема здания. 4. Делает основные выводы по выполненной работе.	

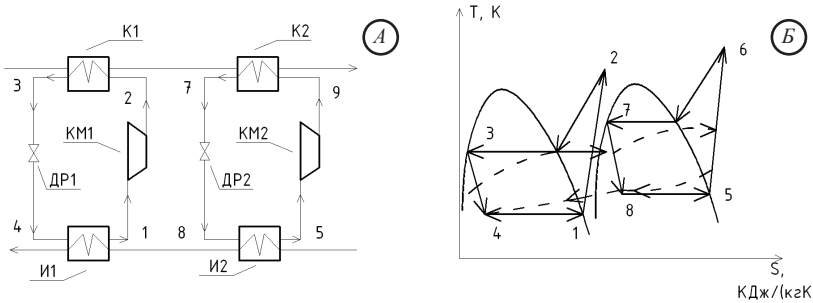
Module M5.4 “Practical recommendations concerning the application of energy saving technologies”

Case Study No.3 “Сравнительный анализ эксплуатационных затрат при использовании на промышленных предприятиях котельных и тепловых насосов”

3.1. Тепловые насосные установки. Последовательное соединение теплонасосной установки

Тепловой насос (ТН) — устройство для переноса тепловой энергии от источника низкопотенциальной тепловой энергии (с низкой температурой) к потребителю (теплоносителю) с более высокой температурой. Термодинамически тепловой насос аналогичен холодильной машине. Однако если в холодильной машине основной целью является производство холода путём отбора теплоты из какого-либо объёма испарителем, а конденсатор осуществляет сброс теплоты в окружающую среду, то в тепловом насосе картина обратная.

Рассмотрим случай, когда несколько ТН соединены последовательнос противоточным движением теплоносителей (см. рис. 1). По сравнению с одной установкой такой же мощности или несколькими ТН, соединенными параллельно по движению теплоносителей, достигаются снижением потерь эксергии в процессах теплообмена. Этот эффект достигается, так как в каждом ТН температуры испарения и конденсации максимально приближаются к температурам теплоносителей.



КМ1, КМ1 – компрессор №1 и №2 соответственно;
ДР1, ДР2 – дроссель №1 и №2 соответственно;
К1, К2 – конденсатор №1 и №2 соответственно;
И1, И2 – испаритель №1 и №2 соответственно;
1, 2, 3, 4, 5, 6, 7, 8 – точки схемы, характеризующие состояние хладагента;
сплошные линии – линии охлаждения на схеме Б;
пунктирные линии – линии нагрева на схеме Б.

Рис.1. Схема последовательного соединения теплонасосных установок по нагреваемому и охлаждаемому теплоносителям с противоточным их движением и график круговых процессов с линиями (штриховыми) нагрева и охлаждения теплоносителей: а) принципиальная схема двухступенчатой теплонасосной установки, б) график кругового процесса двухступенчатой теплонасосной установки.

Схема может быть составлена из ТНУ как с одинаковыми, так и с различными рабочими веществами. Второй вариант по энергетической эффективности предпочтительнее, поскольку в каждой последующей установке (по направлению движения нагреваемого теплоносителя) температура конденсации повышается и при одном и том же рабочем веществе приближается к его критической температуре.

В то же время повышение температуры испарения происходит значительно слабее, так как приемлемое снижение температуры охлаждаемого теплоносителя во всей последовательной цепи испарителей, как правило, невелико. Иными словами, каждый последующий цикл располагается в более высоком и более широком температурном интервале, чем предыдущий.

Так же следует отметить следующее:

1. ТН работают при меньших разностях между температурами теплоприемника и теплоотдатчика, чем установки глубокого охлаждения;
2. Полезным в ТН является не тепловой поток в испарителе, подводимый при постоянной температуре испарения, а тепловой поток, отводимый в теплообменниках верхней части цикла при значительном изменении температуры хладагента (от состояния перегретого пара до состояния охлажденной жидкости)

3.2. Замещение работы котельной, функционирования двух тепловых насосов, соединённых последовательно с противоточным движением теплоносителя

3.2.1. Расчет экономии условного топлива

Мощность, потребляемая электродвигателем теплонаносной установки

$$N_э^к = Qв / \mu \tag{1.1}$$

Потребляемая мощность с учетом потерь в электросетях.

$$N_э = N_э^к / \eta_c \tag{1.2}$$

Расход топлива на КЭС для выработки электроэнергии для привода компрессора теплонаносной установки

$$B_т = N_э^э \cdot b_{кэс} \tag{1.3}$$

где $b^3_{кэс}$=0,340-0,360 кг условного топлива/(кВт·ч) – удельный расход условного топлива (у.т.) на 1 кВт электроэнергии, выработанной на КЭС.

Расход топлива в котельной на выработку тепла

$$B_к = Q_в / Q_{р.н.} \cdot \eta_к \quad (1.4)$$

где $Q_{р.н.}$ - тепловая нагрузка затрачиваемая, на производство 1 кг у.т. котельной, Дж/(ч·кг)

Экономия условного топлива

$$\Delta B = BK - BT \quad (1.5)$$

Экономия условного топлива

$$\Delta b = \Delta B / Q_в \quad (1.6)$$

3.2.2. Расчет для насоса ТН-1

Определить экономию топлива при использовании теплонаносной установки для горячего водоснабжения вместо котельной. Тепловая нагрузка $Q_{в1}$=500 кВт (1,81 ГДж). Коэффициент трансформации теплового насоса μ_1=3,4; КПД электросетей $\eta_с$=0,95; КПД котельной $\eta_к$=0,85

Мощность, потребляемая электродвигателем теплонаносной установки

$$N_{э\ 1}^{к} = 500 / 3,4 = 147,7\ кВт$$

Потребляемая мощность с учетом потерь в электросетях

$$N_{э1} = 88,2 / 0,95 = 154,8\ кВт$$

Расход топлива на КЭС для выработки электроэнергии для привода компрессора теплонаносной установки

$$B_т = 92,9 \cdot 0,350 = 54,2\ кг\ у.т./ч$$

Расход топлива в котельной на выработку тепла

$$B_к = 1,81 \cdot 10^6 / (29300 \cdot 0,85) = 72,5\ кг\ у.т./ч$$

Экономия условного топлива

$$\Delta B = 72,5 - 54,2 = 18,3\ кг\ у.т./ч$$

Удельная экономия у.т. (на единицу отпущенного тепла)

$$\Delta b = 18,3 / 1,08 = 10,2\ кг\ у.т./ГДж$$

3.2.3. Расчет для насоса ТН-2

Определить экономию топлива при использовании теплонаносной установки для горячего водоснабжения вместо котельной. Тепловая нагрузка $Q_{в2}$=500 кВт (1,81 ГДж). Коэффициент трансформации теплового насоса μ_1=2,78; КПД электросетей η_c=0,95; КПД котельной $\eta_к$=0,85.

Мощность, потребляемая электродвигателем теплонаносной установки

$$N_э^к{}_2 = 500 / 2.78 = 179,7\ кВт$$

Потребляемая мощность с учетом потерь в электросетях

$$N_{э2} = 62,63 / 0,95 = 189,3\ кВт$$

Расход топлива на КЭС для выработки электроэнергии для привода компрессора теплонаносной установки

$$B_т = 65,92 \cdot 0,350 = 66,3\ кг\ у.т./ч$$

Расход топлива в котельной на выработку тепла

$$B_к = 1,08 \cdot 10^6 / (29300 \cdot 0,85) = 72,5\ кг\ у.т./ч$$

Экономия условного топлива

$$\Delta B = 72,5 - 66,3 = 6,3\ кг\ у.т./ч$$

Удельная экономия у.т. (на единицу отпущенного тепла)

$$\Delta b_1 = 6,3 / 1,81 = 3,5\ кг\ у.т./ГДж$$

3.2.4. Расчет экономии топливных ресурсов

Суммарная экономия условного топлива составляет

$$\Sigma \Delta b = b_1 + b_2 \qquad (1.7)$$

$$\Sigma \Delta b = 10,5 + 3,5 = 13,6\ кг\ у.т./ГДж$$

Экономия условного топлива в кг на отпуск тепла в час

$$B = \Delta b \cdot (Q_{в1} + Q_{в2}) \qquad (1.8)$$

$$B = 13,6 \cdot 3,6 = 48,96\ кг\ у.\ т.$$

Экономия условного топлива в кг на отпуск тепла в год

$$B_{год} = B \cdot z, \quad (1.9)$$

где z – количество часов в году.

$$B_{год} = 48,96 \cdot 8760 = 428,6 \text{ т у. т.}$$

Годовая экономия нормального топлива

$$B_н = B_{год} / к1 \quad (1.10)$$

где $к_1$ – коэффициент перевода в нормальное топливо.

$$B_н = 428600 / 1,14 = 376000 \text{ м}^3$$

Экономия газа

$$Э_г = B_н \cdot к_2 \quad (1.11)$$

где $к_2$ – стоимость 1 м^3 газа (на 2015 г), руб.

$$Э_г = 376000 \cdot 3,43 = 1289,68 \text{ т. руб}$$

Расход электроэнергии на выработку 1 кВт тепла тепловым насосом

Затраты на электроэнергию год

$$З_т = (N_{э1} + Nэ2) \cdot к_3 \quad (1.12)$$

где $к_2$ – стоимость 1 кВт/ч электроэнергии (на 2015 г), руб

$$З_т = (154.8 + 189.3) \cdot 2,99 \cdot 8760 = 9012,80 \text{ т.р}$$

Расход электроэнергии на выработку 1 кВт тепла котельной насосом

Затраты на электроэнергию в год

$$Э_к = N_к \cdot к_3 \quad (1.13)$$

где $N_к$ – количество электроэнергии потребляемой котельной в год, кВт.

$$Э_к = 417 \cdot 2,99 \cdot 8760 = 10922,23 \text{ т.р}$$

Расчет разницы расхода электроэнергии на выработку 1 кВт тепла

$$9012,8 – 10922,23 = –1909,43 \text{ т.р}$$

Вывод:

На основе расчетов можно сделать вывод, что для промышленных предприятий эксплуатационные затраты при использовании котельной выше, чем при использовании тепловых насосов. Расход электроэнергии на выработку 1кВт тепла тепловым насосом меньше на 1909,43 т.р. в год.

Что делает тьютор?	Что делает студент?	Что делают совместно?
1. Ставит задачу выполнить сравнительный анализ эксплуатационных затрат при использовании на промышленных предприятиях котельных и тепловых насосов. 2. Знакомит с основными видами тепловых насосных установок и их последовательное соединение. 3. Рекомендует вспомогательную литературу. 4. Задает компетенции для данной дисциплины.	1. Осуществляет поиск необходимой информации для решения поставленной задачи. 2. Анализирует и обрабатывает исходную информацию. 3. Выполняет расчет экономии условного топлива, расчеты для двух видов. насосов, расчет экономии топливных ресурсов. 4. Делает основные выводы по выполненной работе.	1. Обсуждают презентации студентов. 2. Формируют замечания по расчету и ходу работы. 3. Участвуют в проведении опроса по формированию компетенций. 4. Получают итоговую оценку.

Co-funded by the
Tempus Programme
of the European Union

УЧЕБНАЯ МАГИСТЕРСКАЯ ПРОГРАММА
«ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ
В СФЕРЕ ЭНЕРГОСБЕРЕЖЕНИЯ
И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ»
«GREEN MASTER»

РАЗРАБОТАНА В РАМКАХ ПРОЕКТА ТЕМПУС
530620-TEMPUS-1-2012-1-IT-TEMPUS-JPCR
«ОБУЧЕНИЕ В ТЕЧЕНИЕ ВСЕЙ ЖИЗНИ И МАГИСТРАТУРА
В ОБЛАСТИ ИННОВАЦИОННЫХ ТЕХНОЛОГИЙ
В СФЕРЕ ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ
В РОССИЙСКИХ УНИВЕРСИТЕТАХ С УЧАСТИЕМ РАБОТОДАТЕЛЕЙ «GREEN MASTER»»

РУКОВОДСТВО ПО ПРОГРАММЕ

Программа обучения разработана в соответствии с европейским измерением
(Подход на основе результатов обучения.)

Инновации:

- подход, ориентированный на студента
- соответствие цели
- результаты обучения – что выпускник будет знать, понимать и будет способен делать после успешного завершения данной образовательной программы
- мероприятия по достижению ожидаемого результата

Партнеры
Российский химико-технологический университет им. Д.И. Менделеева, Москва
Ивановский государственный архитектурно-строительный университет
Ивановский государственный химико-технологический университет
Северо-Осетинский государственный университет им. К.Л. Хетагурова, Владикавказ
Пермский национальный исследовательский политехнический университет
Ставропольский государственный аграрный университет
Тамбовский государственный технический университет
Тюменский государственный архитектурно-строительный университет
Уральский федеральный университет имени первого Президента Б.Н. Ельцина, Екатеринбург
Владимирский государственный университет им. А.Г. и Н.Г. Столетовых
Воронежский государственный архитектурно-строительный университет
Лондонский университет Сити
Силезский технологический университет, Катовице, Польша
Университет Аликанте, Испания
Университет г. Генуи, Италия

ВОРОНЕЖСКИЙ ГОСУДАРСТВЕННЫЙ АРХИТЕКТУРНО-СТРОИТЕЛЬНЫЙ УНИВЕРСИТЕТ
2015

Введение

Университеты	**Воронежский государственный архитектурно-строительный университет, ВГАСУ, Россия**
Уровень программы	**Магистрерская программа**
Статус	**Совместная международная программа**
Название курса	**Проектирование, строительство и обслуживание энергоэффективных и экологичных зданий 08.04.01 (Код образовательной классификации РФ)**
Направление и код классификации	**Строительство 270800 (Код образовательной классификации РФ)**
Квалификация	**Магистр**
Веб-сайт	**http://vgasu.vrn.ru**
Факультет	**магистратуры**
Адрес	**ВГАСУ, Воронеж, 394006, ул. 20-летия Октября, 84**
Срок обучения	**2 года**
Нагрузка	**120 кредитов (в соответствии с Европейской системой перевода и накопления кредитов и Российским образовательным стандартом)**
Запуск программы	**Сентябрь 2014**
Профессиональное признание	**Консультирующие организации при разработке программы:** **- Департамент архитектуры и политики гражданского строительства Воронежской области** **- Институт энергосбережения Свердловской области, Екатеринбург** **- Федеральная служба по защите прав потребителей и благополучия человека, Владимир** **- Союз строителей Свердловской области, Екатеринбург** **- Администрация Тамбовской области** **- ОАО «Энергомера», Ставрополь** **- Воронесжкий проектный институт «Воронежпроект»**
Организация учебного процесса	**Семестры (модули), лекции, практические занятия, лабораторные работы, самостоятельная работа, научное руководство, написание магистерской диссертации.**

Процесс внедрения двухуровневой системы образования в Российской Федерации потребовал изменения единицы для определения учебной нагрузки студента. Это предпринято для гармонизации российской и европейской систем образования. Термин “Российская кредитная единица” (РКЕ), по-английски “Passing unit” был введен в Государственный образовательный стандарт третьего поколения несколько лет назад. Одной РКЕ соответствует 1 кредитная единица европейской системы кредитов.

Сегодня нагрузка:

- Магистерской программы – 120 РКЕ
- Программы бакалавриата – 240 РКЕ
- Программы специалитета – 300 РКЕ

Согласно методике, предложенной Министерством образования РФ
1 Российская кредитная единица (РКЕ) = 36 академическим часам

Цели программы:

Программа GREEN MASTER предлагает студентам возможность углубить свои знания в области энергосбережения и защиты окружающей среды, предоставить студентам специальные знания и понимание устойчивого развития в области энергоресурсов через применение аналитического целостного подхода к устойчивому менеджменту в энергосбережении и охране окружающей среды, что включает в себя теорию и практику. Программа также предусматривает развитие студенческих компетенций в области методологии научных исследований, связанных с развитием и распространением энергосберегающих технологий в строительной и архитектурной средах. Немаловажной целью программы является развитие у студентов способностей решать задачи, возникающие на стадиях проектирования, строительства и обслуживания энергоэффективных и экологичных зданий. Также программой предусмотрено развитие у студентов аналитических навыков, требуемых для управления на высоком уровне, критической оценки и оценки развития в области энергосбережения и эффективного использования природных ресурсов с целью повышения конкурентоспособности путем снижения цен. Выпускник программы Green Master будет экспертом в сфере возобновляемой энергии и энергетическом менеджменте, проектировании.

Образовательная программа предлагает выпускнику следующие программные компетенции (или общие навыки):

Выпускник программы «Green Master» будет обладать комплексными навыками конструирования, оперирования и управления технологическими системами и процессами в основных энергетических отраслях: электричества, отопления и топлива.

Выпускники программы приобретут необходимые навыки концептуального проектирования процессов преобразования энергии и их составляющих. Они смогут оценивать и решать технологические проблемы (термальные, экологические, механические, химические, электрические), которые могут возникнуть в современных системах преобразования энергии.

После завершения программы магистр сможет анализировать и оценивать операционные и эксплуатационные качества энергетических систем, использовать возобновляемые источники энергии и нетрадиционные технологии.

Языки обучения: русский и английский

Вступительные критерии:

- Степень бакалавра или специалиста в соответствующей отрасли науки или техники, имеющей отношение к промышленной химии, химической технологии, гражданскому строительству, энергосбережению, природопользованию и защите окружающей среды; желателен опыт работы в указанных областях.
- Владение английским языком (будет оцениваться в ходе интервью).
- Иностранным кандидатам необходимо иметь сертификат-подтверждение посещения курсов русского языка.

Методы обучения

Процесс обучения организуется в соответствии 3 основным принципам

- усиленный междисциплинарный подход
- подход синтеза различных предметов
- моделирующие инструменты анализа процесса

Результатом данного подхода является профессиональная возможность применять и делиться знаниями в сфере энероэффективности в строительстве и энергоэффективных зданий.

Процесс обучения состоит из семинаров, научного руководства, практических занятий, симпозиумов, занятий по решению проблем, лабораторных работ, стажировок, мобильности, практической деятельности в профессиональной области, электронного обучения.

Отличительной чертой программы является внедрение в нее **последних достижений международного образования**, а именно:

1. Методологии Тюнинга
2. Дублинских дескрипторов
3. Европейской системы перевода и накопления кредитов

В соответствии с «Дублинскими дескрипторами», квалификация, означающая завершение второго цикла, присуждается студентам, окончившим учебную программу, которые:

- продемонстрировали знание и понимание, основанные на и выходящие за рамки знаний, обычно ассоциируемых с уровнем бакалавра, которые составляют основу области обучения;
- показали осведомленность о существующих проблемах и новый взгляд на них, современные инструменты и новые процессы в области знаний, либо развитие профессиональных навыков;
- могут применить свои знания и способность решать задачи в новой или незнакомой среде в широком (или междисциплинарном) контексте, относящемся к их области обучения;
- обладают способностью интегрировать знания, справляться со сложностями и формировать суждения на основе неполной или ограниченной информации, в которых отражается осознание социальной и этической ответственности за применение этих знаний и суждений;
- могут вести или инициировать деятельность и брать на себя ответственность за интеллектуальную деятельность индивидуумов или групп;
- могут четко и ясно передавать свои выводы (а также лежащие в их основе знания и соображения) аудитории специалистов и неспециалистов;
- обладают навыками обучения, позволяющими осуществлять дальнейшее образование с большей степенью самостоятельности и саморегулирования.

Структура программы

Базовые дисциплины

- Основные направления энергосбережения при проектировании, строительстве и обслуживании зданий

Обязательные дисциплины

- Философские проблемы науки и технологии.
- Методология научных исследований.
- Специальные разделы математики.
- Математическое моделирование.
- Основы педагогики и андрагогики.
- Иностранная терминология в области бизнеса и гражданского строительства.
- Информационные технологии в строительстве.
- Методы решения научных и технических задач в строительстве.
- Стандарты и правовые основы энергосбережения.
- Современный мировой опыт в решении задач энергосбережения и повышения эффективности утилизации энергии.
- Жизненный цикл энергоресурсов и объектов недвижимости.
- Теория и практика повышения энергоэффективности.
- Методология баланса циклической динамики энергоресурсов и объектов недвижимости.
- Энергетический баланс и энергетический аудит.
- Методология оценки применения энергосберегающих технологий.

Дисциплины по выбору

- Методы автоматизированного повышения эенргоэффективности.
- Экологический контроль и моделирование энергоэффективных проектных
- Передовые задачи энергосбережения в архитектуре.
- Экологическая безопасность и устойчивое развитие энергии.
- Источники возобновляемой энергии.
- Экономическая оценка применения энергосберегающих технологий.
- Экологические аспекты инвестирования в гражданские строительные проекты.
- «Зеленое строительство» для устойчивого развития территорий

Практическое исследование. Научно-исследовательская работа в семестре.

Практическое исследование. Научно-исследовательская практика.

Магистерская диссертация

Распределение модулей по семестрам

Наименование дисциплины	Кредиты (общий за семестр)	Форма отчетности[i] в текущем семестре	Преподаватели
СЕМЕСТР 1			
М1.1. Философские проблемы науки и технологии	2	Р, З	Доцент Волкова Е.С.
М1.3. Основы педагогики и андрагогики	2	З	Профессор Радугин А.А.
М1.4. Деловой иностранный язык	3	З	Доцент Лукина Л.В.
М2.1. Математическое моделирование	2	З	Профессор Головинский П.А.
М3.1. Стандарты и правовые основы энергосбережения	2	Э	Доцент Исанова А.В.
М3.2. Современный мировой опыт в решении задач энергосбережения и повышения эффективности утилизации энергии	4	Э	Доцент Кононова М.С.
М3.3. Основы энергосбережения и повышения энергоэффективности	3	Э	Профессор Семенов В.Н.
М5.1. Энергетический баланс и энергетический аудит	2	Э	Доцент Исанова, А.В.
М6.1. Экологическая оценка и аудит	3	З	Профессор Сазонов Е.В.
	23		
СЕМЕСТР 2			
М1.2. Методология научных исследований	2	З	Профессор Шитикова М.В.
М2.2. Специальные разделы высшей математики	2	КР, З	Профессор Седаев А.А.
М3.1. Стандарты и правовая база энергосбережения	2	З	Доцент Исанова, А.В.

М4.1. Жизненный цикл энергоресурсов и объектов недвижимости	4	З	Профессор Семенов В.Н.
М4.3. Основные направления энергосбережения при проектировании, строительстве и обслуживании зданий	2	КП, Э	Доцент Семенова Е.Е.
М5.3. «Зеленое строительство» для устойчивого развития территорий	3	З	Доцент Богатова Т.В.
М8.2. Научно-исследовательская работа в семестре	16,5	З	
М8.1. Научно-исследовательская практика	3	З	
М8.1. Педагогическая практика	3	З	
	37.5		
СЕМЕСТР 3			
М2.3. Информационные технологии в гражданском строительстве	3	Э	Доцент Проскурин Д.К.
М2.4. Методы решения научных и инженерных задач в строительстве, связанных с энергосбережением и энергоэффективностью	2	З	Профессор Шитикова М.В.
М4.1. Жизненный цикл энергоресурсов и объектов недвижимости	4	Э	Профессор Семенов В.Н.
М7.1. Методология оценки энергосберегающих процедур.	2	З	Доцент Воробьева Ю.А.
М4.2. Методология баланса циклической динамики энергоресурсов и объектов недвижимости	2	З	Профессор Семенов В.Н.
М5.2. Методы автоматизированного повышения энергоэффективности	3	З	Доцент Китаев Д.Н.

М6.2. Экологическая безопасности и устойчивое развитие энергии.	3	Э	Профессор Сазонов Е.В.
М7.2. Оценка технологий повышения энергоэффективности	3	З	Профессор Сазонов Е.В.
	22		
СЕМЕСТР 4			
М8.2. Научно-исследовательская работа	34,5	test	
М9. Госэкзамен, Защита магистерской работы	3		
	37,5		
Total for 4 semesters	**120**		

Результаты освоения программы

A. Знание и понимание 1. Знание источников энергии, особенности ее генерации и передачи до потребителя. 2. Понимание методов системного подхода к анализу и синтезу процессов энергопотребления. 3. Знание методик технико-экономического анализа процессов энергопотребления. 4. Понимание методов поиска оптимальных решений. 5. Глубокое знание технологии проведения энергоэкоаудита. 6. Понимание предельных термодинамических параметров энергопотребляющих систем. 7. Осознание необходимости комплексного изучения объектов исследования. 8. Знание энергосберегающих систем и оборудования.	**Методы преподавания/обучения** Студенты получают знания, посещая лекции, семинары и лаборатории. Кроме того, проводится большое количество обучающих мероприятий: групповые проекты, анализ конкретного случая, производственная практика, студенческие презентации. Так же привлекаются электронные ресурсы для улучшения качества обучения студентов. Студенты используют большое количество разнообразных учебных материалов: книги, журналы, патенты, а также электронные ресурсы и интернет ссылки. **Методы оценки** Знания и понимание студентов оцениваются разнообразными методами, такими как экзамен, тест, лабораторные отчеты, анализ конкретного случая и презентации студентов.
B. Практические навыки 1. Способность проводить обследование энергопотребляющих систем в целях повышения их энергоэффективности и экологической безопасности. 2. Проведение исследования инструментов диагностики состояний энергетического хозяйства и экологии производств. 3. Составление энергетических и эксергетических балансов на объектах исследования. 4. Выбор критериев оценки вариантов решений в эколого-энергетической сфере. 5. Организация творческих групп для комплексного обследования производственных процессов.	**Методы преподавания/обучения** Студенты приобретают мыслительные навыки, участвуя в семинарах и лабораторных занятиях, выполняя групповые проекты и проекты в мини-группах, анализ конкретного случая, производственной практике, готовя студенческие презентации. Так же привлекаются электронные ресурсы для лучшего развития мыслительных навыков студентов.

<table>
<tr><td>6. Разработка планов работ по энергосбережению.
7. Обоснование выбранных научных подходов к решению целевых задач.
8. Экспресс-анализ потенциальных возможностей энергосбережения.
9. Оценки экологических последствий от реализации энергосберегающих мероприятий.</td><td>Методы оценки
Мыслительные навыки студентов оцениваются разнообразными методами, такими как экзамен, тест, лабораторные отчеты, анализ конкретного случая и презентации. Особый акцент в оценке поставлен на способность студента классифицировать, оценивать, дискутировать, интерпретировать и управлять техникой.</td></tr>
<tr><td rowspan="2">C. Общие навыки
1. Развитие критического мышления и проведение исследований (например, сравнение своих собственных суждений с отличными от них на родном и английском языках).
2. Выбор и использование различных учебных источников в обучающих мероприятиях студентов.
3. Успешное индивидуальное или групповое общение и переговоры с участниками процесса с использованием вербальных, письменных или электронных средств общения (на родном и английском языках).
4. Принятие профессиональных решений, основанных на научном знании и соответствующих критериях.
5. Эффективная групповая или самостоятельная работа для выполнения задания.
6. Выработка навыков эффективного управления временем.
7. Оценка социального воздействия научной и практической работы в изучаемой области.
8. Отражение и оценка своего обучения и профессиональная оценка сокурсников.</td><td>Методы преподавания/обучения
Студенты приобретают общие навыки, посещая семинары и лабораторные занятия, выполняя групповые проекты, анализ конкретного случая, производственную практику, презентации, написание диссертации и посещение специальных модулей. Так же привлекаются электронные ресурсы для лучшего развития мыслительных навыков студентов.</td></tr>
<tr><td>Методы оценки
Выпускные навыки студентов оцениваются такими методами как, написание диссертации, лабораторные отчеты, эссе.</td></tr>
</table>

Описание модулей

Модуль 1	**Теоретические основы научных исследований**
Название дисциплины	М1.1. Философские задачи науки и технологии М1.2. Методология научных исследований М1.3. Основы педагогики и андрагогики М1.4. Иностранный язык в бизнесе
Кредиты	Всего: 9 кредитов, 324 академических часа М1.1. 2 кредита, 72 академических часа М1.2. 2 кредита, 72 академических часа М1.3. 2 кредита, 72 академических часа М1.4. 3 кредита, 108 академических часов
Ведущий модуля	Профессор Шитикова М. В.
Периоды обучения	М1.1. 1 год обучения, 1 семестр М1.2. 1 год обучения, 2 семестр М1.3. 1 год обучения, 1 семестр М1.4. 1 год обучения, 1 семестр
Цели модуля Данный курс представляет студентам текущие задачи научного и технологического развития современного общества. Подготовка студентов к изучению передовых концепций в строительстве, основанных на энергосберегающих технологиях. Углубленное изучение английского как языка для адаптации специфической терминологии в области энергосбережения на всех стадиях проектирования, строительства и обслуживания энергоэффективных зданий и сооружений, для чтения специальной научной и инженерной литературы, для использования международных информационных баз данных, для общения с коллегами в научных и рабочих группах. Изучение истории и влияния Болонского процесса на развитие высшего образования.	
Лекции	Семестр 1: 36 часов Семестр 2: 36 часов
Практические занятия, семинары	Семестр 1: 108 часов Семестр 2: 18 часов
Самостоятельная работа	Семестр 1: 108 часов Семестр 2: 18 часов
Результаты обучения **Знания и понимание** • Формы и методы научного знания. • Передовые тренды в современном научном знании. • Деловой английский язык.	

Практические навыки

- Выбор и применение методов научных исследований.
- Анализ проблем научного и технологического развития общества.
- Устный и письменный английский язык для бизнес-целей.

Общие навыки

- Способность адаптации в продвинутых аспектах строительства.
- Методы научного объяснения и прогнозирования, основанные на энергосберегающих технологиях.
- Уровень английского языка, требуемый для работы в международной междисциплинарной команде

Методы оценки:

Реферат, отчет по практическим работам, презентация, экзамен, анкетирование.

Модуль 2	**Математический анализ и моделирование энергоэффективных систем**
Название дисциплины	М2.1. Математическое моделирование М2.2. Специальные разделы высшей математики М2.3. Информационные технологии в строительстве М2.4. Методы решения научных и инженерных задач в строительстве, связанных с энергосбережением и энергоэффективностью
Кредиты	Всего: 9 кредитов, 324 академических часа М2.1. 2 кредита, 72 академических часа М2.2. 2 кредита, 72 академических часа М2.3. 3 кредита, 108 академических часов М2.4. 2 кредита, 72 академических часа
Ведущий модуля	Профессор Шитикова М. В.
Периоды обучения	М2.1. 1 год обучения, 1 семестр М2.2. 1 год обучения, 2 семестр М2.3. 2 год обучения, 3 семестр М2.4. 2 год обучения, 3 семестр
Цели модуля Основная цель данного модуля – ознакомление студентов с передовыми технологиями математического моделирования, необходимыми для сведения решаемой задачи к набору дифференциальных уравнений, адекватно описывающих рассматриваемый объект. Студенты должны получить общее знание по математическому формулированию физической задачи, выведению основных уравнений в дифференциальной и интегральной формах с последующим их аналитическим и/или численным анализом. Студенты должны развить навыки представления сравнения и оценки сходимости результатов математического моделирования с помощью экспериментальных измерений. Углубленное знание передовых информационных технологий, применимых для задач, возникающих в строительстве.	
Лекции	Семестр 1: 36 часов Семестр 2: 36 часов Семестр 3: 36 часов
Практические занятия, семинары	Семестр 1: 18 часов Семестр 2: 18 часов Семестр 3: 108 часов
Самостоятельная работа	Семестр 1: 18 часов Семестр 2: 18 часов Семестр 3: 36 часов

Результаты обучения

Знания и понимание

- Передовые методы математического анализа для решения задач энергосбережения
- Определение и анализ текущих проблем энергосбережения и их описание адекватными математическими моделями
- Передовые информационные технологии

Практические навыки

- Выбор и применение методов исследований
- Анализ и обобщение результатов научных исследований
- Способность и желание применять знания современных методов научных исследований в инженерной практике.
- Применение новейших информационных технологий в научных исследованиях и инженерной практике

Общие навыки

- Выбор методов теоретической и экспериментально проверок адекватности математических моделей, примененных для решения различных инженерных задач
- Навыки оценки адекватности и точности полученных решений.
- Постоянное изучение информационных технологий

Методы оценки:

Знания студентов и их понимание оцениваются различными методами, такими как анализ упражнений аналитических и численных исследований, лабораторные работы, тесты, студенческие презентации, экзамены.

Модуль 3	**Стандарты энергосбережения, гарантирующие и увеличивающие энергоэффективность**
Название дисциплины	М3.1. Стандарты и правовые основы энергосбережения М3.2. Современный мировой опыт решения задач энергосбережения. М3.3. Основы энергосбережения и повышения энергоэффективности
Кредиты	Всего: 9 кредитов, 324 академических часа М3.1. 2 кредита, 72 академических часа М3.2. 4 кредита, 144 академических часа М3.3. 3 кредита, 108 академических часа
Ведущий модуля	Проф. Семенов В.Н.
Периоды обучения	М3.1. 1 год обучения, 1 семестр М3.2. 1 год обучения, 1 семестр М3.3. 1 год обучения, 1 семестр
Цели модуля Получить глубокие знания стандартов и нормативно-правовой базы энергосбережения в России и странах ЕС, сравнение их достоинств и недостатков. Изучение современного мирового опыта в решении проблем энергосбережения с разных точек зрения. Современные методы повышения энергетической эффективности.	
Лекции	Семестр 1: 30 часов
Практические занятия, семинары	Семестр 1: 60 часов
Самостоятельная работа	Семестр 1: 234 часа
Результаты обучения **Знания и понимание** • Стандарты и нормативно-правовая база энергосбережения • Последний мировой опыт решения проблем энергосбережения • Методы, приводящие к повышению энергоэффективности **Практические навыки** • Применение стандартов и нормативно-правовой базы энергосбережения в инженерной практике • Применение самого современного мирового опыта решения проблем энергосбережения в области научных исследований • Внедрение передовых методов, приводящих к повышению энергетической эффективности на всех этапах проектирования, строительства и эксплуатации зданий	

Общие навыки

- Выбор наиболее эффективного метода для решения какой-либо конкретной проблемы
- Навыки для оценки эффективности полученных решений

Методы оценки:

Тесты, презентации, экзамены.

Модуль 4	**Методология энергосбережения и повышения энергоэффективности**
Название дисциплины	М4.1. Жизненный цикл энергетических ресурсов и объектов недвижимости М4.2. Методология баланса циклической динамики энергетических ресурсов и объектов недвижимости М4.3. Основные направления энергосбережения при проектировании, строительстве и эксплуатации зданий
Кредиты	Всего: 10 кредитов, 360 академических часов М4.1. 4 кредита, 144 академических часа М4.2. 3 кредита, 108 академических часов М4.3. 3 кредита, 108 академических часов
Ведущий модуля	Профессор Семенов В.Н.
Периоды обучения	М4.1. 1 год обучения, 2 семестр, 2 год обучения, 3 семестр М4.2. 2 год обучения, 3 семестр М4.3. 1 год обучения, 2 семестр
Цели модуля Глубокое знание жизненного цикла энергетических ресурсов и объектов недвижимости различного назначения и их взаимосвязи. Методология оценки и оценка эффективности циклической динамики энергетических ресурсов и объектов недвижимости в процессе их строительства и эксплуатации. Состав и оценка основных направлений энергосбережения на всех этапах проектирования, строительства и эксплуатации энергоэффективных зданий, а также их использование в инженерной повседневной практике.	
Лекции	Семестр 2: 54 часа Семестр 3: 18 часов
Практические занятия, семинары	Семестр 2: 108 часа Семестр 3: 18 часов
Самостоятельная работа	Семестр 2: 54 часа Семестр 3: 36 часов
Результаты обучения **Знания и понимание** • Методы анализа и описания жизненного цикла энергетических ресурсов и объектов недвижимости • Методология циклической динамики энергетических ресурсов и объектов недвижимости.	

- Передовые энергосберегающие технологии, используемые для проектирования, строительства и эксплуатации энергоэффективных зданий Знание методик технико-экономического анализа процессов энергопотребления

Практические навыки

- Анализ жизненного цикла различных энергетических ресурсов
- Применение методологии циклической динамики энергетических ресурсов и объектов недвижимости для оценки их текущего состояния
- Применение современных энергосберегающих технологий для проектирования, строительства и эксплуатации энергоэффективных зданий

Общие навыки

- Создание энергоэффективных зданий.
- Навыки углубления в новые энергосберегающие технологии с использованием информации из литературы.

Методы оценки:
Тесты, курсовые проекты, студенческие презентации, экзамены.

Модуль 5	**Теория и практика повышения энергоффективности**
Название дисциплины	М5.1. Энергетический баланс и аудит М5.2. Автоматизированные методы повышения энергоэффективности М5.3. «Зеленое строительство» для устойчивого развития территорий. М5.4. Строительная терминология в английском языке
Кредиты	Всего: 13 кредитов, 468 академических часов М5.1. 4 кредита, 144 академических часа М5.2. 3 кредита, 108 академических часов М5.3. 3 кредита, 108 академических часов М5.4. 3 кредита, 108 академических часов
Ведущий модуля	Профессор Семенов В.Н.
Периоды обучения	М5.1. 1 год обучения, 1 семестр М5.2. 2 год обучения, 3 семестр М5.3. 1 год обучения, 2 семестр М5.4. 1 год обучения, 2 семестр
Цели модуля Целью данного модуля является необходимость ознакомления магистрантов с методами пересмотра энергетических ресурсов и снижения потерь в каждой системе энергоснабжения с одновременным экологическим контролем. Традиционный энергоаудит, описанный в настоящем модуле, включает в себя техническое обследование, анализ эффективности производства энергии и систем потребления для минимизации расхода энергоресурсов. Методы экологического аудита представлены в рамках инвестиционных проектов и создания энергосберегающих программ. В процессе изучения настоящего модуля студент приобретает знания в области энергетики и аудита окружающей среды, а также навыки работы с инструментами для управления энергетики и окружающей среды процессов.	
Лекции	Семестр 1: 18 часов Семестр 2: 18 часов Семестр 3: 72 часа
Практические занятия, семинары	Семестр 1: 36 часов Семестр 2: 54 часа Семестр 3: 72 часа
Самостоятельная работа	Семестр 1: 18 часов Семестр 2: 36 часов Семестр 3: 72 часа

Результаты обучения

Знания и понимание

- Получение знания о методах систематического обследования отраслей промышленности в области энергоэффективности и экологической безопасности
- Понимание организационного порядка аудита энергии и экологии
- Укрепление знания условий аудита и инструментов аудита
- Понимание технологий энергосбережения в отраслях
- Получение знания о «зеленом строительстве» для устойчивого развития территорий

Практические навыки

- Организация энергетического аудита
- Запись / документирование результатов аудита
- Статистические методы обработки данных
- Разработка рекомендаций
- Отчетность аудита Марка
- Осуществление практических рекомендаций по применению энергосберегающих технологий в повседневной инженерной практике

Общие навыки

- Определение целей и задач энергетики и аудита
- Выбор критериев оценки результатов контроля
- Подготовка презентационных материалов
- Подготовка форм для заключения

Методы оценки:

Тесты, студенческие презентации, экзамены.

Модуль 6	**Проблемы окружающей среды в энергосбережении и пути их решения**
Название дисциплины	М6.1. Оценка окружающей среды и аудит М6.2. Экологическая безопасность и устойчивое развитие энергии
Кредиты	Всего: 6 кредитов, 216 академических часов М6.1. 3 кредита, 108 академических часов М6.2. 3 кредита, 108 академических часов
Ведущий модуля	Профессор Сазонов Е.В.
Периоды обучения	М6.1. 1 учебный год, 1 семестр М6.2. 2 учебный год, 3 семестр

Цели модуля

Целью данного модуля является ознакомление магистрантов с методами экологического контроля. Традиционный экологический аудит, описанный в настоящем модуле, включает в себя техническое обследование, анализ экологической безопасности и устойчивого энергетического развития.
В процессе изучения настоящего модуля студент приобретает знания в области энергетики и аудита окружающей среды, а также навыки работы с инструментами для управления энергетикой и процессами окружающей среды.

Лекции	Семестр 1: 36 часов Семестр 3: 36 часов
Практические занятия, семинары	Семестр 1: 36 часов Семестр 3: 36 часов
Самостоятельная работа	Семестр 1: 36 часов Семестр 3: 36 часов

Результаты обучения

Знания и понимание

- Демонстрация понимания и принятие методов экологического контроля
- Анализ экологической безопасности и энергетики устойчивого развития
- Знания в области энергетики и аудита окружающей среды, а также навыки в работе с инструментами для управления энергетикой и процессами в окружающей среде

Практические навыки

- Организация экологического аудита
- Запись / документирование аудита
- Статистические методы обработки данных
- Разработка рекомендаций
- Отчетность аудита Марка

Общие навыки

- Умение оценить экологическую безопасность
- Возможность реализации вопросов энергетики в области устойчивого развития в инженерной практике

Методы оценки:

Тесты, презентации, экзамены.

Модуль 7	**Экономическое обоснование применения энергосберегающих технологий**
Название дисциплины	М7.1. Методика оценки эффективности реализации энергосберегающих аспектов М7.2. Оценка технологий повышения энергетической эффективности
Кредиты	Всего: 4 кредита, 144 академических часа М7.1. 2 кредита, 72 академических часа М7.2. 2 кредита, 72 академических часа
Ведущий модуля	Профессор Семенов В.Н.
Периоды обучения	М7.1. 2 год обучения, 3 семестр М7.2. 2 год обучения, 3 семестр
Цели модуля Этот модуль предоставит студентам знания методологии для оценки эффективности внедрения энергосберегающих аспектов на всех этапах проектирования, строительства и обслуживании энергоэффективных зданий. Будут даны экономические аспекты для оценки технологий, приводящих к повышению энергетической эффективности.	
Лекции	Семестр 3: 15 часов
Практические занятия, семинары	Семестр 3: 30 часов
Самостоятельная работа	Семестр 3: 99 часов
Результаты обучения **Знания и понимание** • Получение знания методов расчета экономической эффективности производств • Получение знания о методологии для оценки эффективности внедрения энергосберегающих аспектов на всех этапах проектирования, строительства и эксплуатации энергоэффективных зданий • **Практические навыки** • Навыки для оценки передовых технологий, приводящих к повышению энергоэффективности • Оценка качества полученных решений с учетом экономических критериев	

Общие навыки

- Навыки оценки передовых технологий, приводящих к повышению энергетической эффективности и их дальнейшего использования в инженерной практике
- Критическая оценка качества полученных решений на основе передовых экономических критериев

Методы оценки:

Тесты, презентации, экзамены.

Модуль 8	**Научно-исследовательская работа в семестре Научная и педагогическая практики**
Кредиты	Всего: 57 кредитов, 2052 академических часа М8.1. 6 кредитов, 216 академических часов для практики М8.2. 51 кредит, 1836 академических часов для написания магистерской квалификационной работы
Ведущий модуля	Профессор Семенов В.Н. и научные руководители
Периоды обучения	М8.1. 1 год обучения, 2 семестр М8.2. 2 год обучения, 3 семестр 2 год обучения, 4 семестр

Цели модуля

Модуль будет осуществляться в сотрудничестве с научным руководителем в промышленных организациях / исследовательских центрах / университетских лабораториях. Студенты будут включены в научные исследования и практическую деятельность с возможной будущей перспективой занятости. Студенты будут выполнять проекты и задачи, поставленные организациями. Этот опыт даст им возможность предпринять инициативы, а также развивать уверенность в себе, межличностные и адаптационные навыки. Научно-исследовательская деятельность в процессе создания и выполнения их магистерской диссертации будет готовить студентов для будущей работы в научно-исследовательских и проектных институтах, занимающихся вопросами энергосберегающих технологий на всех этапах проектирования, строительства и эксплуатации энергоэффективных зданий и сооружений.

Методы оценки:

Для проведения исследований на основе экспериментальных работ, получение результатов, точность и достоверность, доказывающее, обзор данных, выявление причинно-следственных связей, определение исследований инновационной и соответствующих функций.

Результаты исследований будут включены и реализованы в магистерской диссертации.

Модуль 9	**Общий Госэкзамен. Защита магистерской диссертации**
Кредиты	3 кредита, 108 академических часов
Ведущий модуля	Все научные руководители.
Периоды обучения	2 год обучения, 4 семестр
Цели модуля Подготовка магистерской квалификационной работы в соответствии с требованиями.	
Методы оценки: Подготовка магистерской диссертации и прохождение итоговой государственной аттестации. Ценные практические результаты магистерской диссертации и их применение для региональной экономики и социально-экономической среды.	

Методы оценки

- Внутренний текущий контроль знаний студента согласно процедурам по IQnet и ISO-9000 (в конце каждого семестра)
- Устные презентации
- Отчеты о производственной практике
- Профессиональные портфолио
- Письменные отчеты и эссе (включающие список литературы)
- Тесты после каждой темы, экзамены по предметам, оценка и защита магистерской диссертации
- Постеры
- Оценивание студентами друг друга
- Самооценка

Обеспечение качества

Внутреннее

- Общая профессиональная оценка Оценочной комиссии проекта
- Отзывы студентов

Внешнее

- Оценка европейскими учеными из университетов- партнеров
- Официальное признание Министерства образования и науки РФ
- Оценка работодателей

Возможные области трудоустройства

Выпускники магистерской программы имеют возможность трудоустройства на предприятиях строительной отрасли и ЖКХ, в архитектурных мастерских, в лабораториях, научно-исследовательских центрах по изучению проблем энергосбережения и повышения энергоэффективности промышленных систем.

Список рекомендуемой литературы

1. Kishimoto A. Advanced Energy Saving and its Applications in Industry, 2013. – 75 p.
2. Li Xianguo Green Energy. Basic Concepts and Fundamentals, 2011. – 288 p.
3. Magrini A. Building Refurbishment for Energy Performance, 2014. – 252 p.
4. Hakansson A. Sustainability in Energy and Buildings / Proceedings of the 4th International Conference in Sustainability in Energy and Buildings (SEB´12), 2013. – 554 p.
5. Howlett Robert J. Sustainability in Energy and Buildings/ Results of the Second International Conference in Sustainability in Energy and Buildings (SEB'10), 2011. – 302 p.
6. M'Sirdi N. Sustainability in Energy and Buildings / Proceedings of the 3rd International Conference on Sustainability in Energy and Buildings (SEB´11), 2012. – 650 p.
7. Lee Shaun H. Sustainability in Energy and Buildings / Proceedings of the International Conference in Sustainability in Energy and Buildings (SEB'09), 2010.
8. Ziębik A. Energy Systems of Complex Buildings, 2013. – 345 p.
9. Zamfirescu C. Sustainable Energy Systems and Applications, 2012. – 816 p.
10. Geller G. Sustainable Rural and Urban Ecosystems: Design, Implementation and Operation. Manual for Practice and Study, 2012. – 179 p.
11. Rassia Stamatina Th. Sustainable Environmental Design in Architecture. Impacts on Health, 2012. – 338 p.
12. Rassia Stamatina Th. Cities for Smart Environmental and Energy Futures Impacts on Architecture and Technology, 2014. – 301 p.
13. Ortigueira, Manuel Duarte Fractional Calculus for Scientists and Engineers, 2011. –154 p.
14. Lizárraga-Celaya C. Maple and Mathematica. A Problem Solving Approach for Mathematics, 2nd ed., 2009. – 484 p.
15. Wagon St. Mathematica® in Action. Problem Solving Through Visualization and Computation, 3rd ed., 2010. – 574 p.
16. Borwein Jonathan M. An Introduction to Modern Mathematical Computing With Mathematica®, 2012. – 224 p.
17. Sibikin, M. Sibikin. Alternatives and Renewables energy sources, 2012.

18. V.I. Vissarionov, G.V.Deriugina etc. Solar energy, 2011.
19. A.B. Alhasov. Renewable power generation, 2010.
20. O.D. Samarin. Thermo-physical and technical- economic foundations of Thermal Engineering safety and energy efficiency in buildings, 2007.
21. A.N. Dmitriev, Y.A. Tabunshikov etc. Manual on estimation of economical efficiency of investment in energy-efficiency, 2010.
22. I.M. Kvashnin. Emission limited values of plants into the atmosphere. Dispersion and establishment of standards. 2011.
23. M.M.Brodach. Industrial emission into the atmosphere. Engineering analyses and inventory, 2011.
24. Y.A. Tabushnikov, M.M. Borodach. Mathematical modeling and optimization of buildings' thermal effectiveness, 2012.
25. V.N. Karpov. Hot water heating systems of multi-storey buildings. Technical guidelines for the design, 2012 Instruction on the calculation of heat loss in rooms and thermal loads on the heating of residential and public buildings, 2012.
26. New English-Russian , Russian-English dictionary of technical terms and phrases for Heating, Ventilation , Air-Conditioning , and Thermal Physics, 2011.
27. M.M. Brodach. Engineering equipment of high-rise buildings, 2011.
28. Technical guideline on the organization of ventilation in the apartments of residential buildings, 2011.
29. V.M.Magadeev. Sources of heat supply system, 2013.
30. A.Salihov. Unvalued and unrecognized ''small'' energy, 2009.

Учебный план магистерской программы «Инновационные технологии в сфере энергосбережения и экологического контроля» «Green Master»

Модуль	A 1	A 2	A 3	A 4	A 5	A 6	A 7	B 1	B 2	B 3	B 4	B 5	B 6	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8
M1. Теоретические основы научных исследований		x	x	x				x	x	x				x	x	x	x			x	
M2. Математический анализ и моделирование энергоэффективных систем	x	x	x			x	x	x	x	x	x	x	x	x		x	x	x		x	x
M3. Стандарты энергосбережения, гарантирующие и повышающие энергоэффективность	x	x	x	x			x	x	x		x		x	x	x		x				x
M4. Методология энергосбережения и повышение энергоэффективности	x	x	x	x	x		x	x	x	x	x		x	x	x		x	x		x	
M5. Теория и практика повышения энергоэффективности		x	x	x		x	x	x	x	x	x	x		x	x		x	x	x	x	
M6. Проблемы окружающей среды по энергосбережению и пути их решения	x	x		x	x		x	x	x	x	x		x	x	x		x	x		x	x
M7. Экономическое обоснование применения энергосберегающих технологий			x	x			x	x				x	x	x	x	x			x	x	
M8. Научно-исследовательская работа в семестре Научная и педагогическая практики.								x	x	x	x	x	x	x	x	x	x	x	x	x	x
M9. Магистерская выпускная работа	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Результаты программы

Знание и понимание	
A1	Фундаментальные знания и понимание инновационных технологий в энергосбережении и контроле окружающей среды
A2	Понимание оптимизационного подхода и методов энерго- и ресурсосбережения
A3	Знание основ энергосбережения на основе развития зеленых технологий
A4	Знание административных норм и правил в области охраны окружающей среды
A5	Углубленное знание проектирования, строительства и обслуживания энергоэффективных зданий и энергосберегающих технологий
A6	Знание математических и аналитических концепций для решения задач энергоэффективности на всех стадиях проектирования, строительства и эксплуатации энергоэффективных зданий
A7	Критическая оценка текущих методов производства и утилизации энергии
Практические навыки	
B1	Способность вносить технический и управленческий вклады в планирование энерго- и ресурсосберегающих проектов (на родном и на английском языках).
B2	Способность решать инженерные задачи путем применения теоретических концепций и практических знаний на производстве
B3	Способность проводить лабораторные и полевые эксперименты, собирать, анализировать и интерпретировать данные
B4	Выбор и использование соответствующих методов и технологий энерго- и ресурсосбережения
B5	Использование соответствующих информационных технологий для инженерных и управленческих целей
B6	Способность проектировать энергоэффективные здания
Общие навыки	
C1	Развитие критического мышления и проведение научных исследований (например, представить критически и сравнить свои собственные взгляды с теми, которые отличаются от них (на родном языке и на английском языке)
C2	Определение и использование различных ресурсов в студенческой научной занятости

C3	Эффективное общение и переговоры с различными заинтересованными сторонами в индивидуальном порядке и в группе
C4	Принятие обоснованных профессиональных решений, основанных на научных знаниях и соответствующих критериях
C6	Развитие эффективных навыков планирования времени
C7	Ценить социальные последствия исследований и практической работы в области изучения
C8	Задумываться и оценивать свое собственное обучение и оценивать коллег в профессиональной манере

Дидактические материалы программы

Серия учебников была разработана и напечатана специально для новой программы при взаимодействии российских и европейских преподавателей и включает 9 учебников и глоссарий проекта.

	Название учебника	**Редактор книги**
1.	Российский химико-технологический университет имени Д. И. Менделеева	
	Зеленые технологии для устойчивого развития	Н. Тарасова
2.	Тамбовский государственный технический университет	
	Повышение энергоэффективности природо-промышленных систем	Н. Попов
3.	Университет г. Генуи	
	Основы термодинамики и эксергетический анализ	Л. Тальяфико
4.	Уральский федеральный университет им. Б.Н. Ельцина	
	Жизненный цикл энергии. Энергетический менеджмент и принятие оптимальных решений	Н. Ширяева
5.	Тамбовский государственный технический университет	
	Энергетический и экологический аудит	Н. Попов
6.	Российская академия архитектуры и строительных наук	
	Инженерный и экономический анализ энергосберегающих мероприятий	С. Федосов
7.	Ставропольский государственный аграрный университет	
	Экологическая безопасность и энергоустойчивое развитие	Н. Корнилов
8.	Воронежский государственный архитектурно-строительный университет	
	Практическое применение энергосберегающих технологий	В. Семенов
9.	Владимирский государственный университет им. А.Г. и Н.Г. Столетовых	
	Моделирование природных и промышленных систем	Ю. Панов
20.	Университет г. Генуи и Тамбовский государственный технический университет	
	Глоссарий проекта GREENMA	А. Мусаио Л. Мозерова

QUACING Agency
for the Quality Certification and EUR-ACE
Accreditation of Engineering Programmes
ENQA Affiliate

Prot. n. 54/16 del 27/07/2016

Università degli Studi di Genova
Area Ricerca, Trasferimento tecnologico e Internazionalizzazione
Servizio Relazioni Internazionali
Via Balbi, 5
16126 Genova

Ref.: **Assignment of tasks for accreditation of the Programme handbook, GREENMA Tempus Project**

The present letter to confirm that on July 2016 we completed the overall revision of the programme handbooks of the following six Master programmes in "Innovative Technologies for Energy Saving and Environmental protection (GREEN MASTER)":

- 'Innovative Technologies for Energy Saving and Environmental Protection', D. Mendeleyev University of Chemical Technology of Russia, Moscow, Russia;
- 'Innovative Technologies for Energy Saving and Environmental Control', Stavropol State Agrarian University, Stavropol, Russia;
- 'Innovative Technologies for Energy Saving and Environmental Control', Tambov State Technical University, Tambov, Russia;
- 'Innovative Technologies for Energy Saving and Environmental Control', Vladimir State University n. a. Alexander and Nikolay Stoletovs, Vladimir, Russia;
- 'Design, construction and maintenance of power effective and eco-friendly buildings', Voronezh State University of Architecture and civil Engineering, Voronezh, Russia;
- 'Design and operating of heating system, gas supply, ventilation and air conditioning', Ural Federal University n.a. the First President of Russia B. N. Eltsin, Yekaterinburg, Russia;

with specific reference to the 'Identification of the educational needs of the labour market and other stakeholders', 'Definition of the educational objectives', "Definition of the learning outcomes', 'Definition of the educational process'.

Agenzia QUACING
Via XX Settembre 5
00187 ROMA

www.quacing.it
segreteria@quacing.it

The attached certificates attest the conformity of the design process to the student-centred approach and the coherence of the educational objectives with the educational needs of the labour market of reference, of the learning outcomes with the educational objectives and of the educational process with the learning outcomes of each Master programme.

Best regards.

Vito Cardone
President

Agenzia QUACING
Via XX Settembre 5
00187 ROMA

www.quacing.it
segreteria@quacing.it

QUACING Agency
for the Quality Certification and EUR-ACE
Accreditation of Engineering Programmes
ENQA Affiliate

Certificate

of conformity of the design process to the student-centred approach and of coherence among educational objectives, learning outcomes and educational process of the Master programme

Design, construction and maintenance of power effective and eco-friendly buildings

of the

Voronezh State University of Architecture and civil Engineering, Voronezh, Russia

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"

The programme handbook lists the educational objectives of the programme, expressed in terms of competences to be developed and obtained by students at the end of the educational process, established in agreement with stakeholders of the labour market of reference.

The programme handbook prosecutes with the list of the programme learning outcomes to be achieved by students at the end of the educational process in order to develop and obtain the established educational objectives. The learning outcomes are grouped under the headings 'knowledge and understanding', 'practical (or disciplinary) skills' and 'graduate (or transferable) skills'.

Then the programme structure is presented, with the description of the learning outcomes associated to each module of the programme, again grouped under the headings 'knowledge and understanding', 'practical skills' and 'graduate skills'.

The steps of the design of the programme evidenced by the programme handbook are consistent with the student-centred approach, which requires first the identification of the educational needs of the stakeholders, then the definition of the programme aims (educational objectives), followed by the definition of the programme learning

Agenzia QUACING
Via XX Settembre 5
00187 ROMA

www.quacing.it
segreteria@quacing.it

outcomes and of the programme structure, with the definition of the module learning outcomes.

The results of the analysis of the educational objectives established in agreement with stakeholders of the labour market of reference, of the programme learning outcomes and of the module learning outcomes show that the programme learning outcomes are substantially coherent with the educational objectives and the module learning outcomes are substantially coherent with the programme learning outcomes.

Therefore, with the present certificate QUACING Agency attests:

- the conformity of the design process of the Master programme 'Design, construction and maintenance of power effective and eco-friendly buildings' of the Voronezh State University of Architecture and civil Engineering, Voronezh, Russia, with the student-centred approach, and
- the coherence among educational needs of the labour market of reference, educational objectives, learning outcomes and educational process of the Master programme.

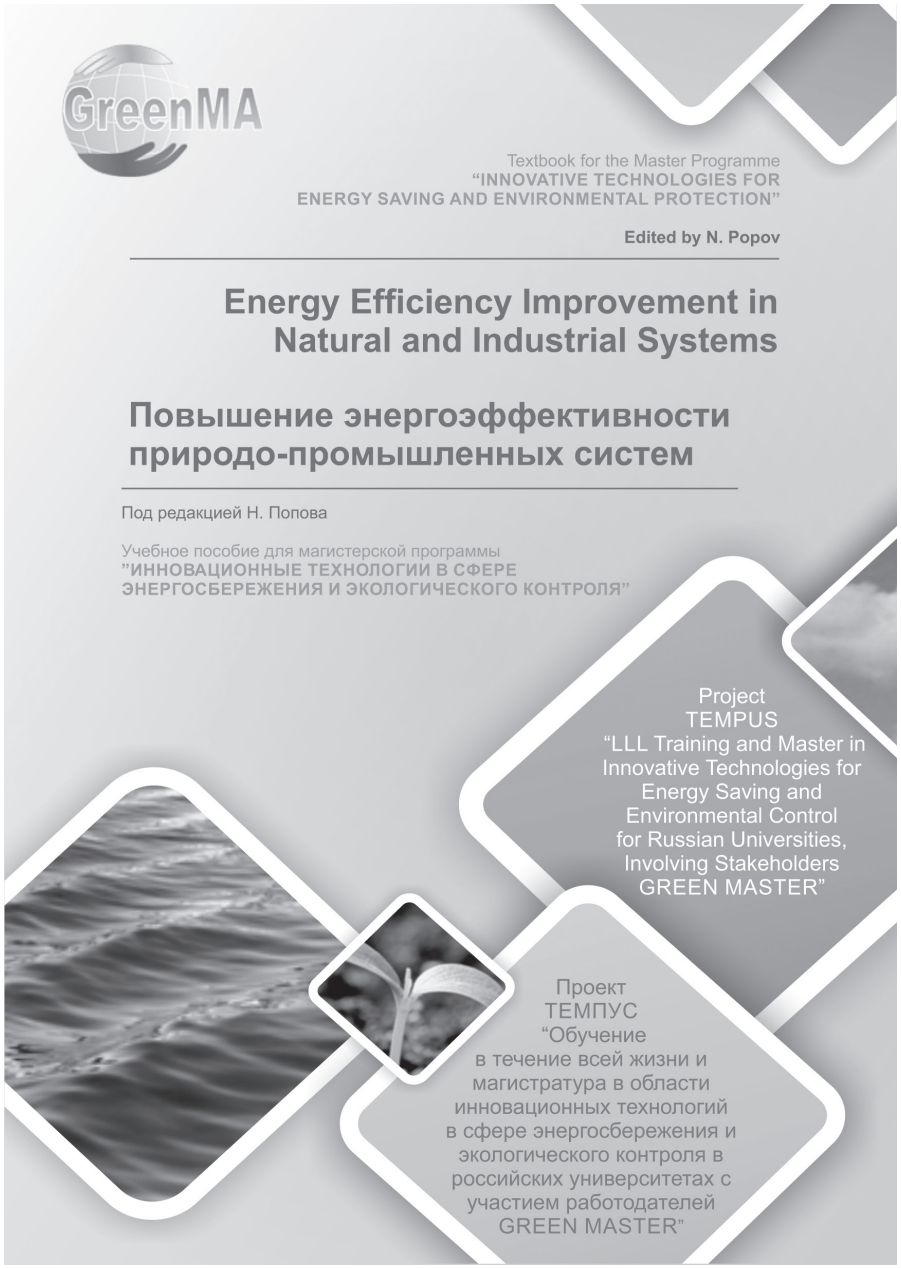
Roma, 27/7/2016

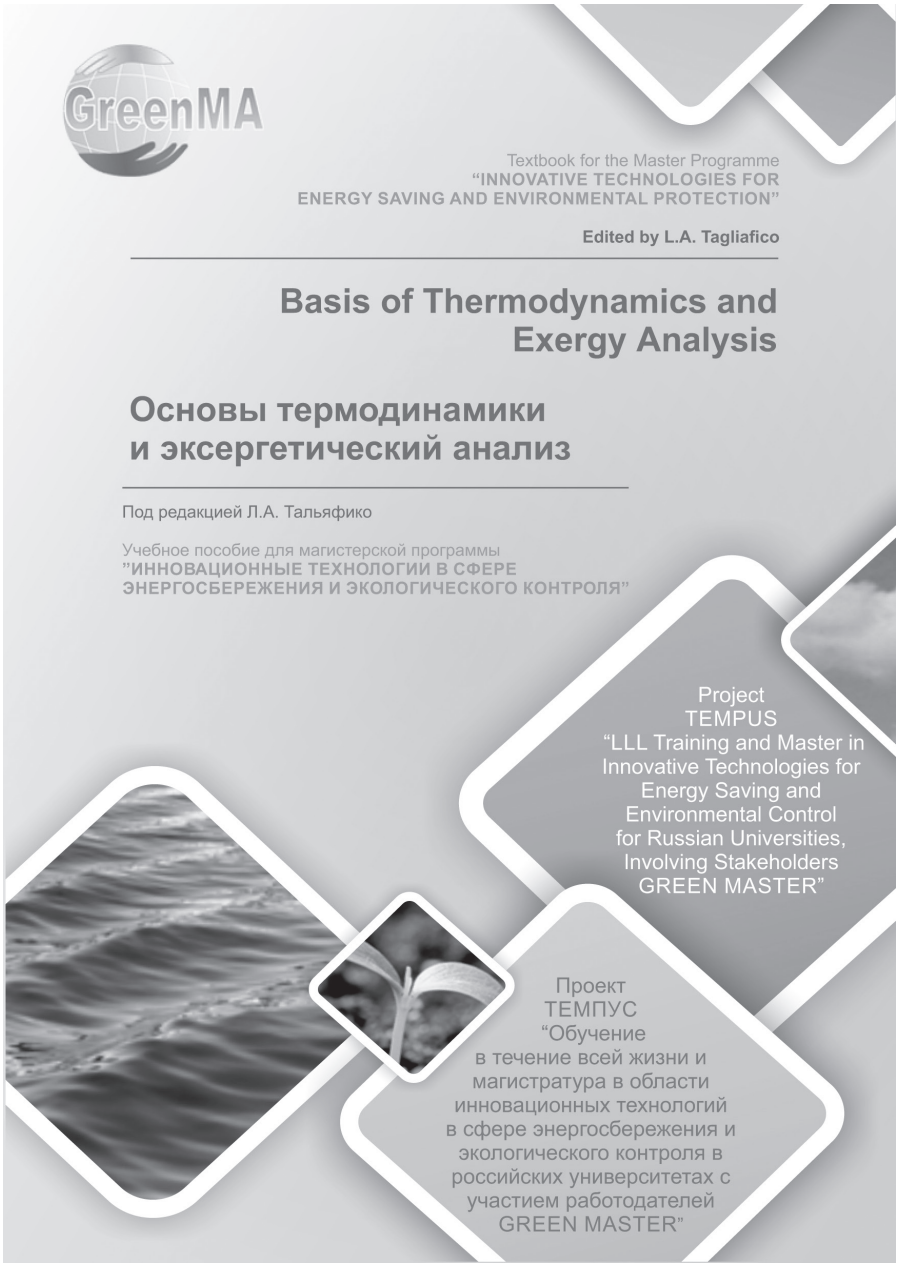
Vito Cardone
President

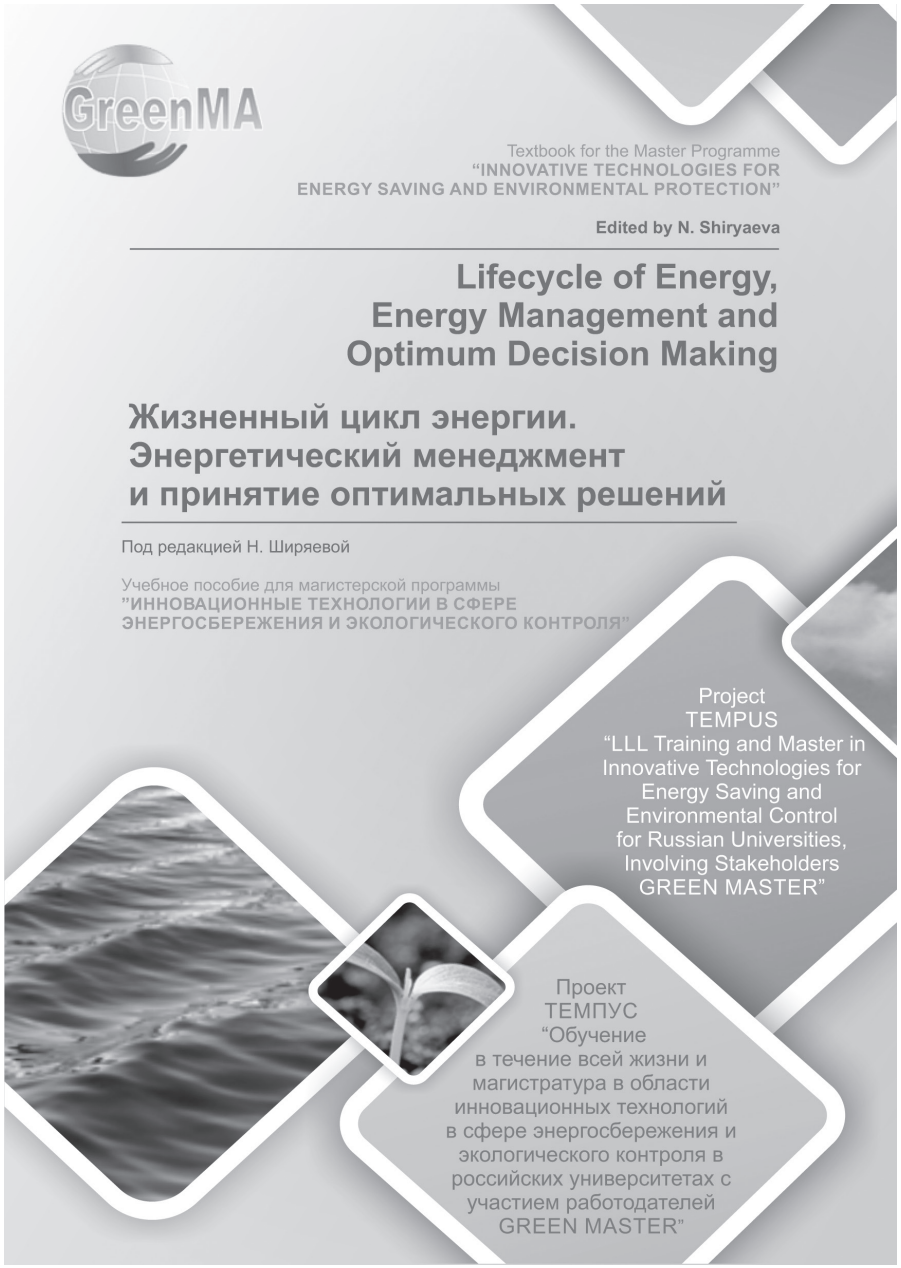
Agenzia QUACING
Via XX Settembre 5
00187 ROMA

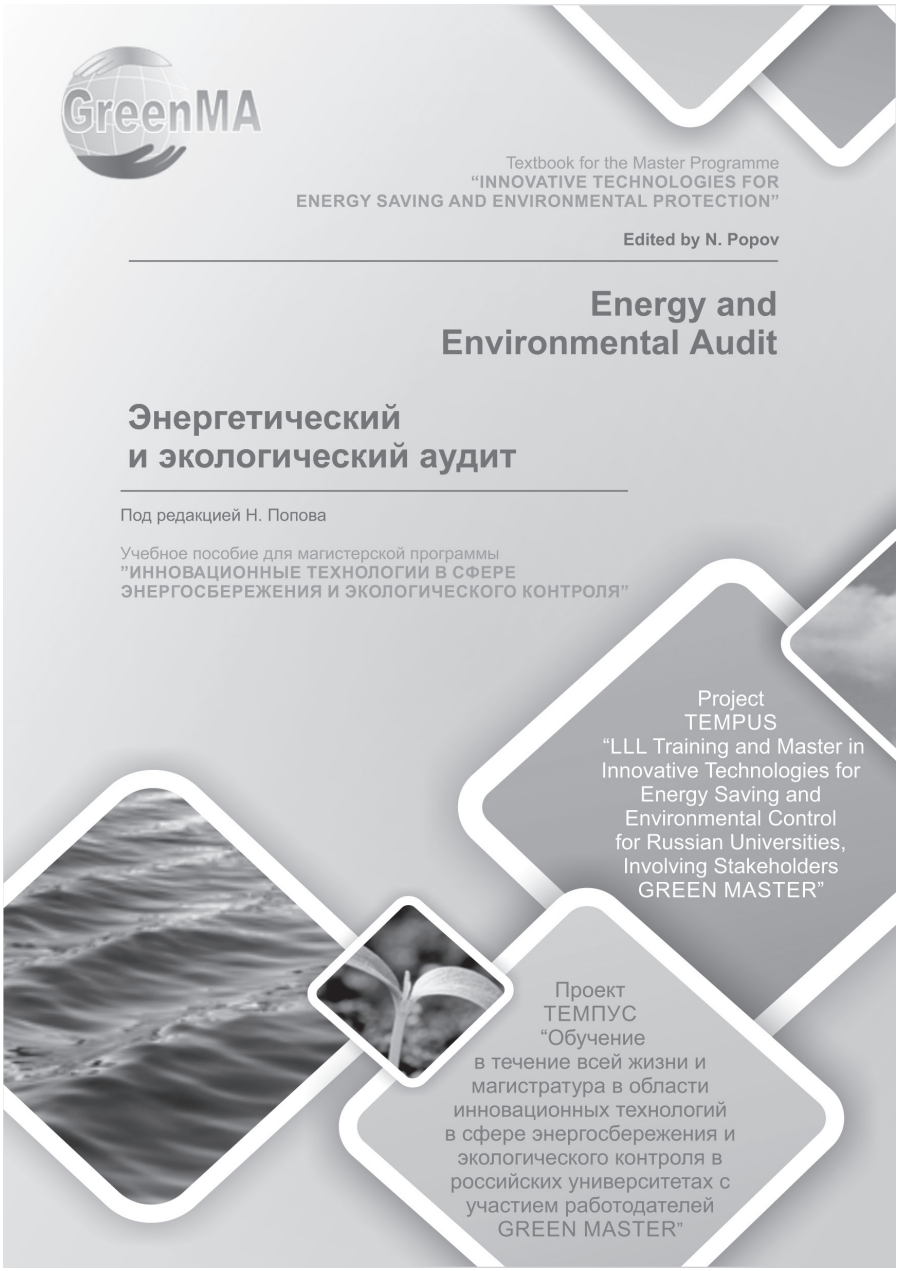
www.quacing.it
segreteria@quacing.it

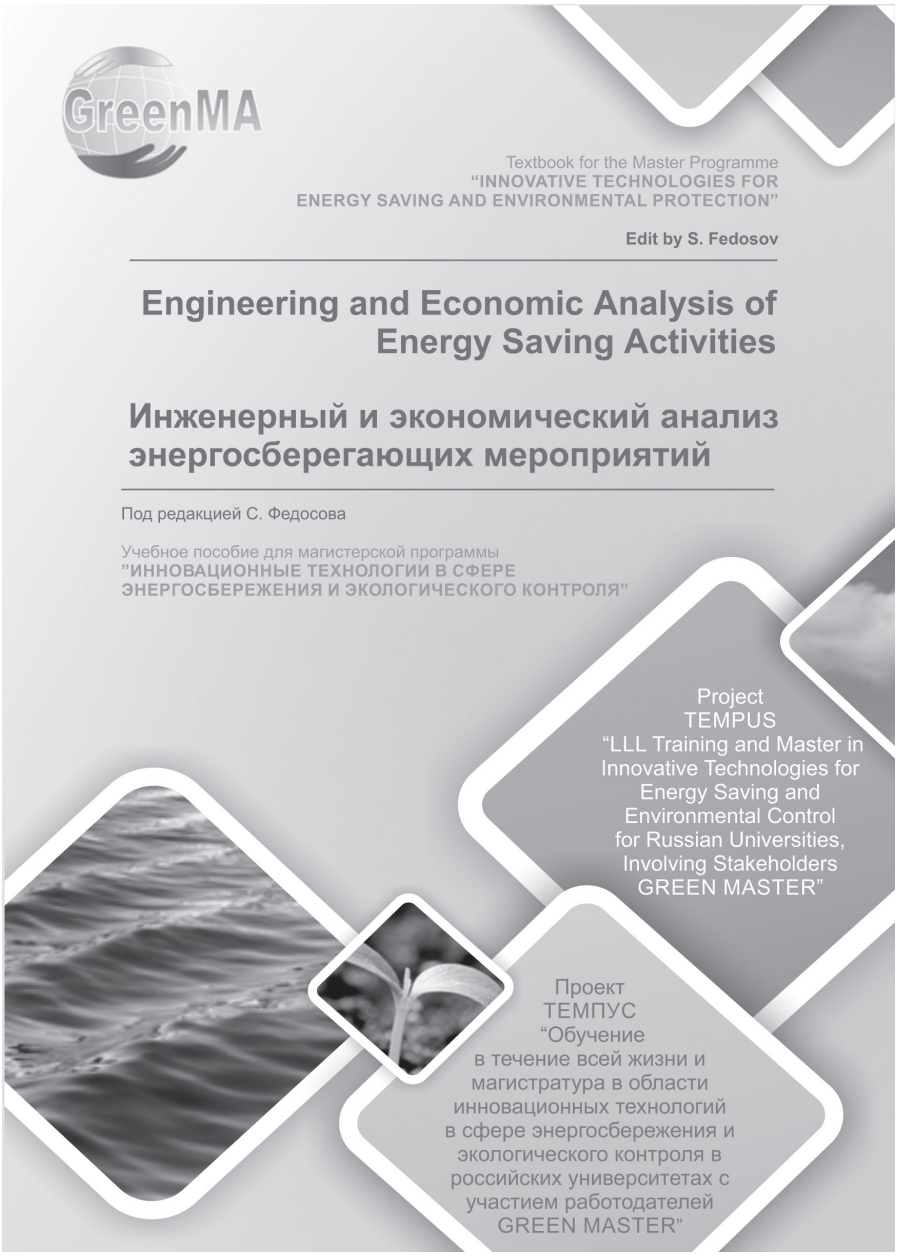

GreenMA
Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"
Edited by N. Tarasova
Green Technologies for
Sustainable Development
Зеленые технологии
для устойчивого развития
Под редакцией Н. Тарасовой
Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"
Project
TEMPUS
"LLL Training and Master in
Innovative Technologies for
Energy Saving and
Environmental Control
for Russian Universities,
Involving Stakeholders
GREEN MASTER"
Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"

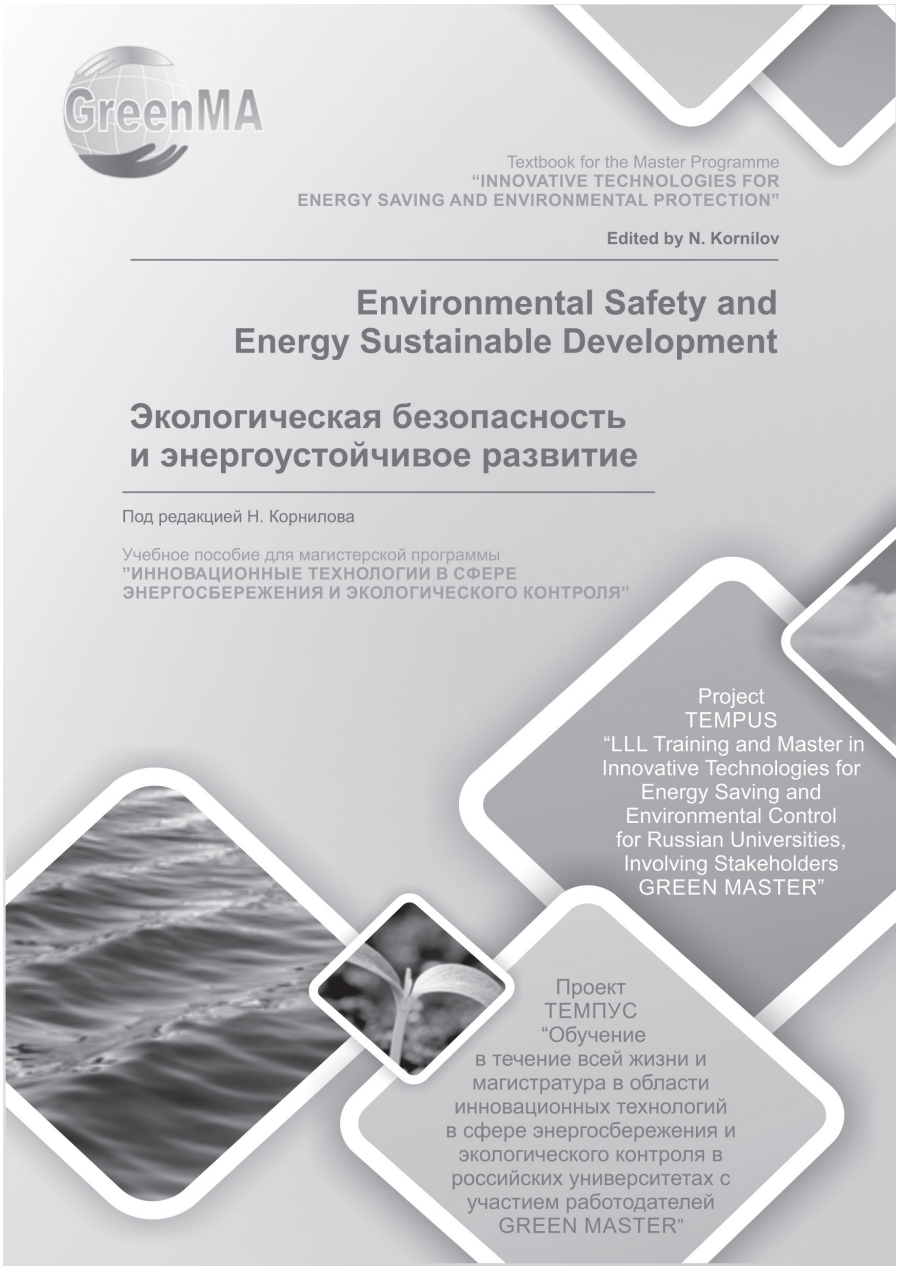

GreenMA
Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"
Edited by N. Popov
Energy Efficiency Improvement in
Natural and Industrial Systems
Повышение энергоэффективности
природо-промышленных систем
Под редакцией Н. Попова
Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"
Project
TEMPUS
"LLL Training and Master in
Innovative Technologies for
Energy Saving and
Environmental Control
for Russian Universities,
Involving Stakeholders
GREEN MASTER"
Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"

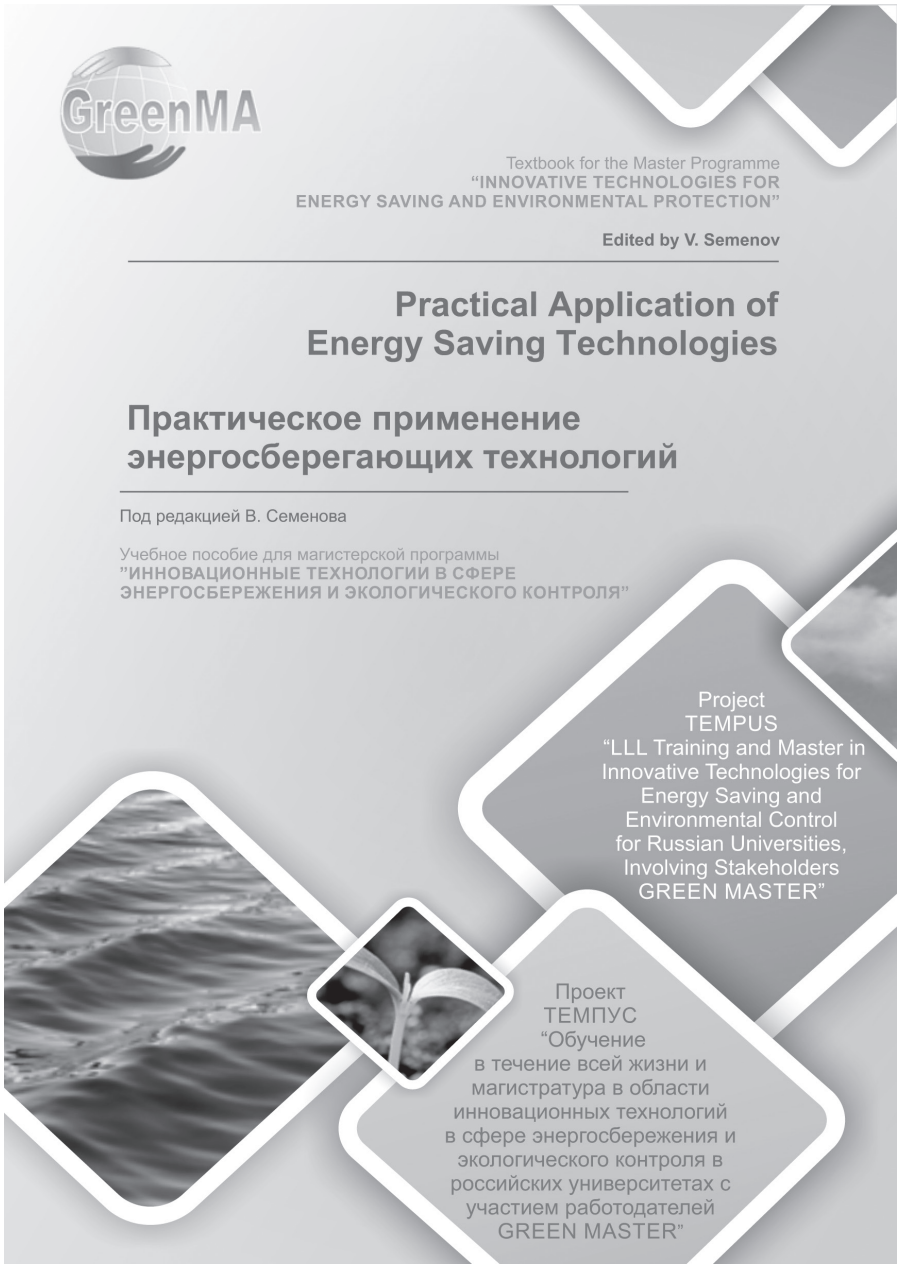

GreenMA
Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"
Edited by L.A. Tagliafico
Basis of Thermodynamics and
Exergy Analysis
Основы термодинамики
и эксергетический анализ
Под редакцией Л.А. Тальяфико
Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"
Project
TEMPUS
"LLL Training and Master in
Innovative Technologies for
Energy Saving and
Environmental Control
for Russian Universities,
Involving Stakeholders
GREEN MASTER"
Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"

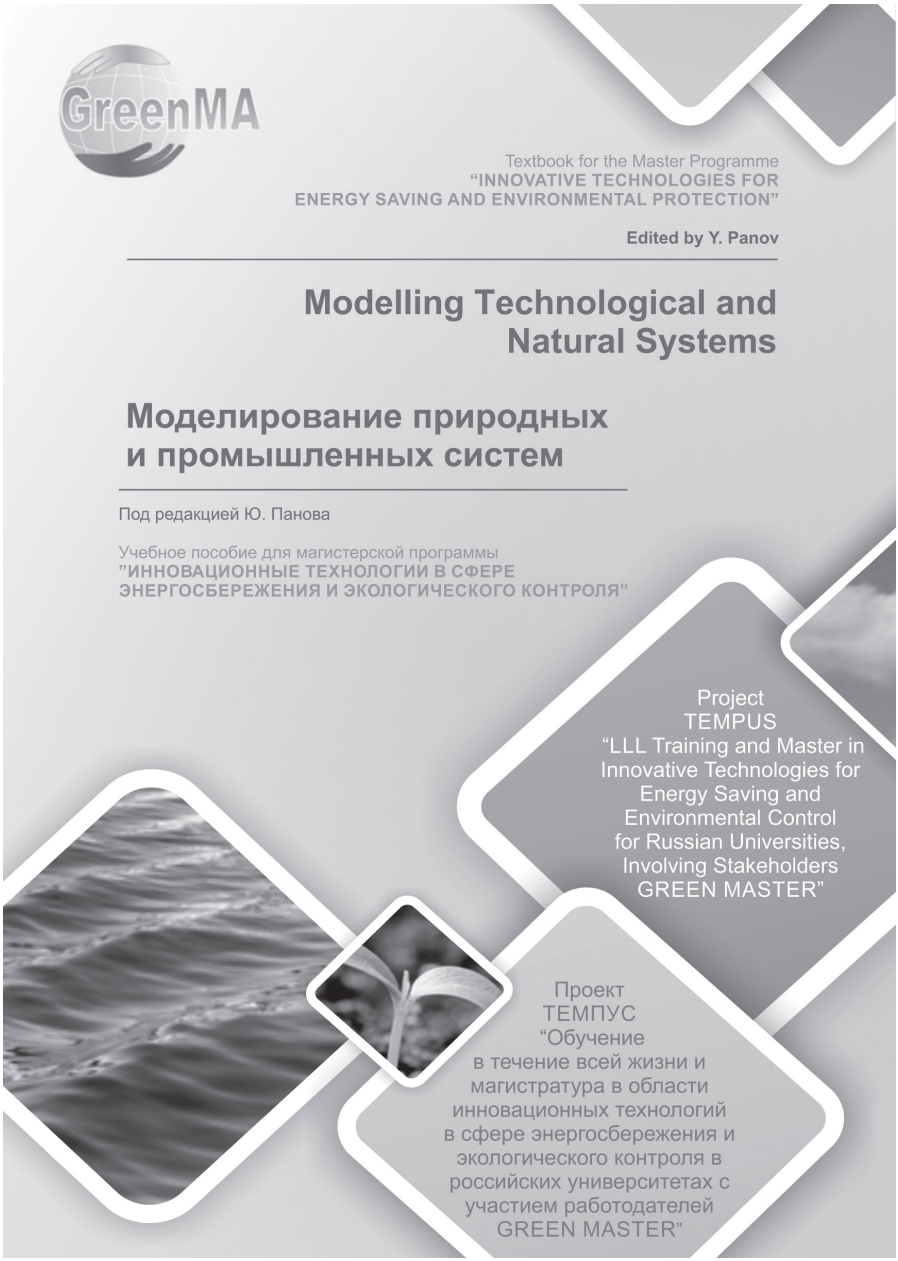

GreenMA
Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"
Edited by N. Shiryaeva
Lifecycle of Energy,
Energy Management and
Optimum Decision Making
Жизненный цикл энергии.
Энергетический менеджмент
и принятие оптимальных решений
Под редакцией Н. Ширяевой
Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"
Project
TEMPUS
"LLL Training and Master in
Innovative Technologies for
Energy Saving and
Environmental Control
for Russian Universities,
Involving Stakeholders
GREEN MASTER"
Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"


GreenMA
Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"
Edited by N. Popov
Energy and
Environmental Audit
Энергетический
и экологический аудит
Под редакцией Н. Попова
Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"
Project
TEMPUS
"LLL Training and Master in
Innovative Technologies for
Energy Saving and
Environmental Control
for Russian Universities,
Involving Stakeholders
GREEN MASTER"
Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"


GreenMA
Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"
Edit by S. Fedosov
Engineering and Economic Analysis of Energy Saving Activities
Инженерный и экономический анализ энергосберегающих мероприятий
Под редакцией С. Федосова
Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"
Project
TEMPUS
"LLL Training and Master in Innovative Technologies for Energy Saving and Environmental Control for Russian Universities, Involving Stakeholders GREEN MASTER"
Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"


GreenMA
Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"
Edited by N. Kornilov
Environmental Safety and
Energy Sustainable Development
Экологическая безопасность
и энергоустойчивое развитие
Под редакцией Н. Корнилова
Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"
Project
TEMPUS
"LLL Training and Master in
Innovative Technologies for
Energy Saving and
Environmental Control
for Russian Universities,
Involving Stakeholders
GREEN MASTER"
Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"


GreenMA
Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"
Edited by V. Semenov
Practical Application of
Energy Saving Technologies
Практическое применение
энергосберегающих технологий
Под редакцией В. Семенова
Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"
Project
TEMPUS
"LLL Training and Master in
Innovative Technologies for
Energy Saving and
Environmental Control
for Russian Universities,
Involving Stakeholders
GREEN MASTER"
Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"


GreenMA
Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"
Edited by Y. Panov
Modelling Technological and
Natural Systems
Моделирование природных
и промышленных систем
Под редакцией Ю. Панова
Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"
Project
TEMPUS
"LLL Training and Master in
Innovative Technologies for
Energy Saving and
Environmental Control
for Russian Universities,
Involving Stakeholders
GREEN MASTER"
Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"

GreenMA

Textbook for the Master Programme
"INNOVATIVE TECHNOLOGIES FOR
ENERGY SAVING AND ENVIRONMENTAL PROTECTION"

Edited by A. Musaio, L. Mozerova

Glossary for GREENMA Project

Глоссарий проекта GREENMA

Под редакцией А. Мусайо, Л. Мозеровой

Учебное пособие для магистерской программы
"ИННОВАЦИОННЫЕ ТЕХНОЛОГИИ В СФЕРЕ
ЭНЕРГОСБЕРЕЖЕНИЯ И ЭКОЛОГИЧЕСКОГО КОНТРОЛЯ"

Project
TEMPUS
"LLL Training and Master in
Innovative Technologies for
Energy Saving and
Environmental Control
for Russian Universities,
Involving Stakeholders
GREEN MASTER"

Проект
ТЕМПУС
"Обучение
в течение всей жизни и
магистратура в области
инновационных технологий
в сфере энергосбережения и
экологического контроля в
российских университетах с
участием работодателей
GREEN MASTER"

Tempus

GreenMA

PARTNERSHIP AND COOPERATION AGREEMENT

"NETWORK INTRA RUSSIAN-EUROPEAN UNION SMART COMMUNITIES ON SHARED SUSTAINABLE DEVELOPMENT.

GREENMA NETWORK"

AMONG THE CONSORTIUM MEMBERS OF TEMPUS "GREENMA" PROJECT

1. UNIVERSITY OF GENOA (UNIGE), Italy;
2. TAMBOV STATE TECHNICAL UNIVERSITY (TSTU), Russian Federation;
3. URAL FEDERAL UNIVERSITY n.a. BORIS ELTSIN (URFU), Russian Federation;
4. VLADIMIR STATE UNIVERSITY n.a. STOLETOVS (VLSU), Russian Federation;
5. STAVROPOL STATE AGRARIAN UNIVERSITY (SSAU), Russian Federation;
6. VORONEZH STATE UNIVERSITY OF ARCHITECTURE AND CIVIL ENGINEERING (VSUACE), Russian Federation;
7. TYUMEN STATE UNIVERSITY OF ARCHITECTURE AND CIVIL ENGINEERING (TSUACE), Russian Federation;
8. IVANOVO STATE UNIVERSITY OF CHEMISTRY AND TECHNOLOGY (ISUCT), Russian Federation;
9. NORTH OSSETIAN STATE UNIVERSITY n.a. K.L. KHETAGUROV (NOSUK), Russian Federation;
10. D. MENDELEYEV UNIVERSITY OF CHEMICAL TECHNOLOGY OF RUSSIA (MUCTR), Russian Federation;
11. PERM NATIONAL RESEARCH POLYTECHNIC UNIVERSITY (PNRPU), Russian Federation;
12. IVANOVO STATE POLYTECHNIC UNIVERSITY (IVSPU), Russian Federation;
13. CITY UNIVERSITY OF LONDON (CULUK), United Kingdom;
14. SILESIAN UNIVERSITY OF TECHNOLOGY (SUTPL), Poland;
15. UNIVERSIDAD DE ALICANTE (UDAES), Spain;
16. INSTITUTE OF ENERGY SAVING (INES), Russian Federation;
17. FEDERAL SERVICE ON CUSTOMERS' RIGHTS PROTECTION & HUMAN WELL-BEING (ROSPONVL), Russian Federation;

18. UNION OF CONSTRUCTORS OF SVERDLOVSK REGION (UCOSR), Russian Federation;
19. TAMBOV REGIONAL ADMINISTRATION (TRA), Russian Federation;
20. TICASS CONSORTIUM (TICASS), Italy;
21. ENERGOMERA JSC (ENERG), Russian Federation.

In the framework of Tempus "GREENMA" Project on "Innovative Technologies for Environmental Monitoring and Energy Saving. Green Master" (530620–TEMPUS–1–2012–1–IT–TEMPUS–JPCR), coordinated by the University of Genoa, hereinafter referred to as the project, the consortium members institutions of the said project, hereinafter referred to as the partners, being represented by their respective Rectors or First Vice Rectors or Deputy Rectors for International Relations, considering that:

a) the partners are committed to carry out and foster actions aimed at the so-called "Smart City", in which solutions able to reduce pollution and save energy are pursued;
b) the partners desire to provide the academic community (students, teaching staff, researchers), in the EU Member States and in the Russian Federation, with a broad range of curricula and unique learning, teaching and research experience in topics related to the technologies for Environmental Monitoring and Energy Saving;
c) the partners wish to get a permanent feedback from relevant and outstanding stakeholders on their own socio-economic environments;
d) the partners pursue to establish an EU - Russia network on shared sustainable development, having three main outcomes:
    i. to discuss the creation of cluster companies and other networking tools;
    ii. to realize an integrated system for research, training and innovation;
    iii. to increase the competitiveness of the involved regions and to foster their development;

e) the partners intend to foster the positive experience of the project, and have a mutual interest in creating and developing international cooperation agreements;
f) the partners are interested in: developing delivery of double degrees; internships for students and graduates; master classes; mobility of students, teachers, managers and researchers, in addition to meetings and possible convergence processes towards joint integrated educational models;
g) the partners take commitment to promote original, sustainable and low-costs projects, also proposed by third parties,

hereby agree as follows.

The partner n. 22, "NORTH-CAUCASUS FEDERAL UNIVERSITY" (NCFU), Stavropol, Russian Federation, integrates the list of the participating institutions, in its position of Russian University involved in Tempus project "GREENCO - Green Computing and Communication" (530270-TEMPUS-1-2012-1-UK-TEMPUS-JPCR), having aims and objectives similar to the GREENMA ones.

Article 1. Aims and objectives

The Parties commit to spread the common values defined by the GREENMA project with specific reference to Environmental Monitoring and Energy Savings. The non-university members of the GREENMA project consortium express their commitment to foster work experience actions targeted to the GREENMA graduates.

By the present agreement, the Parties undertake to:

a) organise joint study programmes, destined for the development of study courses at the various levels, including for purposes of awarding a double degree;
b) promote scholarship for research / training development in the partner universities and institutions, also for brief periods;
c) increase the exchange of professors, researchers, students and technical - administrative personnel;

d) enhance co-operation in the field of scientific research, through collaboration in activities of particular scientific interest, as well through the possibility of exchange of experiences in the use of particularly complex technical and scientific equipment.

The Parties take commitment to pursue Smart Cities & Communities (SCC) vision of sustainable urban and territorial development. Based on this vision, European Union and Russian Federation institutions should be places of advanced social progress and environmental regeneration, as well as places of attraction and engines of economic growth based on a holistic integrated approach in which all aspects of sustainability are taken into account.

The parties take commitment to cooperate across the areas of energy, transport, environment, and information & communication, in order to accelerate the deployment of innovative technologies, organisational and economic solutions to significantly increase resource and energy efficiency, improve the quality of life and drastically reduce greenhouse gas emissions in urban areas. Multi-sectorial, international collaboration, specialized knowledge and relevant expertise from many different organizations is in fact vital to make Smart Cities a reality.

Article 2. Implementation agreements

The present agreement defines the general rules for its execution and for the governance of the relations within the said partnership. In order to achieve the objectives indicated in Article 1, specific implementation agreements shall be prepared for defining and ruling working programmes or other actions, on a reciprocal basis, both at bilateral and multilateral level. Such agreements shall be submitted for the approval of the respective competent bodies of the Parties involved in such actions and will be aimed at developing the following actions:

1. integrated didactic and scientific activities, including the development of Teachers' mobility for brief and intensive periods of visit;

2. integrated Study Programmes for students, graduate and PhD students to enrol for study periods, training and specialization courses in partner Universities' excellence structures;
3. starting up of new joint study courses degree and PhD degree with double value or Master and specialization courses;
4. increase of joint research activities, also among affiliated work groups of the partners;
5. reciprocal expertise mobility flows aimed at delivering master classes lectures on subjects suggested by the hosting University;
6. delivering of training modules to be attended by employees of the stakeholders;
7. development of database reporting data and info relevant on environmental protection and energy savings.

The said implementation agreements shall:

- quote that the specific working programme or action is implemented in the framework of the present agreement;
- be sent in copy to the coordinator of the above-mentioned Tempus project.

Article 3: Contact persons

A support office is designated to oversee and facilitate the implementation of any further agreement stipulated pursuant to the present agreement. Such office is the International Relations Service (SRI) of the University of Genoa, mail: <intstrat@unige.it>.

For the definition of coordination and supervision of the present agreement and/or setting-up of more specific programmes and actions, the partners shall refer to a Steering Committee. This Committee shall be composed by the contact persons of the above-mentioned Tempus project partners, by the head of the above-mentioned support office (SRI) and by the Vice Rector for International Relations of the University of Genoa, who shall act as coordinator of the Steering Committee.

Article 4. Exchange of personnel

In order to achieve the contents of Article 1 and the development of the specific implementation agreements, exchanges of partners' personnel may be planned, in accordance with the terms of the following paragraphs.

University personnel maintain, to all intents and purposes, the status of employees of their home university.

In general terms, travel costs, mobility expenses, board and lodging have to be paid by the home university or by specific funds available for this purpose.

In accordance with the principle of reciprocity and with the regulations in force in the Institutions involved, the host university can pay further remuneration to the university personnel for additional lessons, seminars and conferences.

The Parties involved shall assist in arranging for permissions for approved staff to enter and leave the Countries concerned, whenever necessary for the implementation of this agreement.

Article 5. Exchange of students

During the exchange period, the students, under conditions of reciprocity, are exempt from tuition fees and contributions in the host university, except for teaching and training courses having particular provisions.

Travel costs as well as board and lodging expenses have to be paid by students attending integrated study programmes. The home university may contribute to these expenses, provided specific funds are available for this purpose. The host university shall assist students in finding accommodation, as well as allow them access to canteens and other services provided by the university to its own students.

Article 6. Duration, termination, renewal

This agreement shall come into effect upon the signature of all the Parties.

6

The date of the last signature thereof taking precedence. This agreement shall remain in effect for five years. No tacit renewal will be allowed at the expiry of this Agreement. Each Party may terminate this agreement by serving six months' written notice and supplying adequate motivation for termination. Any activity in progress at the moment of termination or expiry of this agreement shall be completed in accordance with the conditions established in the activity's specific implementation agreement. The termination of this agreement, for any reason, should not influence the status of delegated student to each University or hinder them from continuing their studies for the desired qualification.

Each University shall implement this agreement according to the executive procedure determined by the concerned academic boards.

Amendments to this agreement can only be made after consultation and written mutual consent by all the Parties.

In the event of renewal of this agreement, the Parties may confirm, amplify or modify the objectives of this agreement and the methods of implementation, subject to the approval of the respective competent bodies.

Article 7. Intellectual property rights

Ownership of the technical and scientific results produced by this agreement shall, unless established differently by a specific implementation agreement, be assigned to both Parties. In accordance with their respective legislations, the Parties shall take all reasonable steps to protect and promote the value of such results. In the event of results produced through separate research initiatives, the intellectual property rights of these results shall belong to the Party where the results are obtained, unless otherwise previously agreed.

In order to promote the marketability of the results obtained, the implementation agreements shall also establish ex ante the procedure to be adopted in the face of

possible claims to property rights made by personnel belonging to one of the Parties or by those in contact with such personnel.

All the partners listed in the preamble have equal right to use the GREENMA trademark as registered and recognized by the competent Russian Federation's authorities.

Article 8: Confidentiality of Information

The Parties shall take all reasonable steps not to divulge to third parties any confidential data or information acquired in relation to or in the carrying out of the activities foreseen by this agreement.

Article 9: Costs, assistance and support

With the aim of carrying out the activities foreseen by this agreement, the Parties shall raise the necessary economic resources within the limits of and in accordance with legislation in force in their countries. Each Party shall provide, in accordance with their respective laws and regulations, all necessary assistance and support to visiting students, teaching staff, researchers, and technical and administrative personnel as established in the specific implementation agreements mentioned at article 2.

The costs related to the initial stipulation of the network will be on charge of the GREENMA project budget.

Article 10: Safety

As regards safety in the workplace for visiting members of staff of the partner University, where the host University belongs to an EU Member State, the host University shall conform to applicable European Union legislation; where the host University belongs to a non-EU Member State, the host University shall conform to applicable national legislation.

Article 11: Insurance

In accordance with the applicable provisions in force of their respective countries, both Parties shall verify the insurance cover, including healthcare, of participating personnel.

Where the implementation agreements set forth in Article 2 foresee scientific and laboratory activities, such implementation agreements shall specify the details of insurance cover.

Article 12: Handling of Personal Data

The Parties shall handle and store data held on computer and on hard copies relating to the carrying out of the activities foreseen both by this agreement and the implementation agreements set forth in Article 2 in accordance with their applicable national legislations.

Article 13: Incompatibility

The Parties declare that none of the personnel participating in the activities foreseen by this agreement find themselves in a situation that might give rise to incompatibility or conflicts of interest pursuant to applicable national legislations and that the related provisions of such legislations shall be respected at all times.

Article 14: Disputes and Final Provisions

The Parties consider this agreement as a declaration of intent that does not have the legal force of a formal legal contract. The Parties agree therefore, wherever possible, to seek an amicable resolution of any dispute.

The specific cooperation initiatives described shall be started only if sufficient economic resources are available; no Party shall be obliged to participate in or develop an activity for which external or internal resources are not already available.

The resolution of any disputes arising during the carrying out of any executive project as referred to in Article 2 shall conform to the provisions established in the project's specific implementation agreement. In all cases, the present agreement shall apply solely to the extent it does not contradict applicable national legislation.

The present agreement is issued in English language and signed in original by each party. The Parties receive one copy each. If either party wants to issue a version of this Agreement in a language other than English, and in case of inconsistency of interpretation, the English text shall prevail over the language texts.

~~~~~~~~~~~~~~~~~~~~~~~~~~~~

10
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Genoa, 31st May 2016

For the University of Genoa

Rector

Professor COMANDUCCI Paolo

Seal

London, 11th August 2016

For the Partner n° 13 [CULUK]

City University of London

DEPUTY VICE CHANCELLOR
PROFESSOR CONSTANTINE ARCOUMANIS

Seal

The City University
School of Engineering
and Mathematical
Sciences

Genoa, 31st May 2016

For the University of Genoa

Il Rettore

Rector

Professor COMANDUCCI Paolo

Seal

Stavropol, _____

For the Partner n° 21 [ENERG]

ENERGOMERA JSC

3rd JUNE 2016

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Yekaterinburg, 21st June 2016

For the Partner n° 16 [INES]

Institute of Energy Saving of Sverdlovsk Oblast

1 JUN 2016

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Ivanovo, _____

For the Partner n° 8 [ISUCT]

Ivanovo State University of Chemistry and Technology

Rector

Prof. BUTMAN Mikhail

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Ivanovo, 3rd JUNE 2016

For the Partner n°12 [IVSPU]

Ivanovo State Polytechnic University

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector Il Rettore

Professor COMANDUCCI Paolo

Seal

Moscow, 27th June 2016

For the Partner n° 10 [MUCTR]

D.Mendeleyev University of Chemical Technology of Russia

Acting Rector

Prof. YURTOV Evgeniy

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector

Professor COMANDUCCI Paolo

Seal

Vladikavkaz, 07 ИЮЛ 2016

For the Partner n° 9 [NOSUK]

North Ossetian State University n.a. K.L. Khetagurov

Rector

Prof. SOZANOV Valeriy

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Perm, 3 JUN 2016

For the Partner n° 11 [PNRPU]

Perm National Research Polytechnic University

Rector

Prof. TASHKINOV Anatoly

Genoa, 31st May 2016

For the University of Genoa

Rector Il Rettore

Professor COMANDUCCI Paolo

Seal

Vladimir, 06.07.2016

For the Partner n° 17 [ROSPONVL]

Federal Service on Customers' rights protection & Human Well-being

Director of the Service

Mrs. DANILOVA Tatiana

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector

Professor COMANDUCCI Paolo

Seal

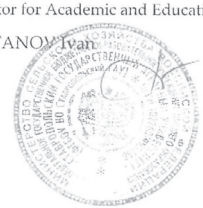
Stavropol, 1 JUN 2016

For the Partner n° 5 [SSAU]

Stavropol State Agrarian University
Vice Rector for Academic and Educational Work

Prof. ATANOV Ivan

Seal



Genoa, 31st May 2016

For the University of Genoa

Rector

Professor COMANDUCCI Paolo

Seal

Gliwice, 24.08.2016

For the Partner n° 14 [SUTPL]

Silesian University of Technology

Pełnomocnik Dziekana
ds. Współpracy z Zagranicą i Wymiany Studentów

Prof. Aleksander SŁADKOWSKI

Seal

RT
WYDZIAŁ TRANSPORTU
POLITECHNIKA ŚLĄSKA
40-019 Katowice, ul. Krasińskiego 8
tel. 603-41-08, 603-41-40

Genoa, 31st May 2016

For the University of Genoa

Rector Il Rettore

Professor COMANDUCCI Paolo

Seal

Genoa, 3rd JUNE 2016

For the Partner n° 20 [TICASS]

TICASS Consortium

TICASS S.c.r.l.
TECNOLOGIE INNOVATIVE PER IL CONTROLL
AMBIENTALE E LO SVILUPPO SOSTENIBILE

Seal

Sede Legale
Via B. Bosco 57/4
16121 Genova
P. IVA: 01955820993

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Tambov, _____

For the Partner n° 19 [TRA]

Tambov Regional Administration

Head of Nature Mngt and Environment Protection Dept.

Mrs. PETROVA Nadezhda

7.06.2016

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Tambov, 7.06.2016

For the Partner n° 2 [TSTU]

Tambov State Technical University

Vice-Rector for International Relations

Prof. MISHCHENKO Elena

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Tyumen, 16.09.2016

For the Partner n° 7 [TSUACE]
For the Partner n° 7 [TSUACE]
Tyumen State University of Architecture and Civil Engineering

(former TSUACE) Tyumen Industrial University

Rector

Prof. NOVOSELOV Oleg

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Yekaterinburg, 21st June 2016

For the Partner n° 18 [UCOSR]

Union of Constructors of Sverdlovsk Region

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Alicante, 23rd August 2016

For the Partner n° 15 [UDAES]

Universidad de Alicante

HEAD OF INTERNATIONAL COOPERATION

Dr. Roberto ESCARRE

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector Il Rettore

Professor COMANDUCCI Paolo

Seal

Yekaterinburg, 21st June 2016

For the Partner n° 3 [URFU]

Ural Federal University n.a. Boris Eltsin

Rector

Prof. KOKSHAROV Victor

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Vladimir, 10.06.2016

For the Partner n° 4 [VLSU]

Vladimir State University named after A.G. and N.G. Stoletovs

Rector

Prof. SARALIDZE Anzor

10.06.2016.

Seal

Genoa, 31st May 2016

For the University of Genoa

Rector *Il Rettore*

Professor COMANDUCCI Paolo

Seal

Voronezh, - 1 JUN 2016

For the Partner n° 6 [VSUACE]

Voronezh State University of Architecture and Civil Engineering

Rector

Prof. SUROVTSEV Igor

Seal

Учебное издание
СПРАВОЧНИК ПО МАГИСТЕРСКОЙ ПРОГРАММЕ
«ПРОРЕКТИРОВАНИЕ, СТРОИТЕЛЬСТВО И ЭКСПЛУАТАЦИЯ
ЭНЕРГОЭФФЕКТИВНЫХ И ЭКОЛОГИЧНЫХ ЗДАНИЙ»

Учебное пособие

ООО «Рекон»,
392000, г. Тамбов, ул. Урожайная, 2 д.,
e-mail: print@435300.ru
тел. 8 (4752) 43-53-00
Формат 60x90/16. Бумага офсетная. Печать электрографическая.
Гарнитура Times. Усл. печ. л. – 7,25. Тираж 100 экз.

ISBN 978-5-9909811-4-0

Co-funded by the
Tempus Programme
of the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.