Ministry of Agriculture of the Republic of Kazakhstan
S. Seifullin Kazakh agrotechnical University

The Academic Council of the University
considered
2022 «13» 05
protocol № 14

Approve
Chairman of the board of JSC
"K... ...der S. Seifullin
... K. Aituganov

EDUCATIONAL PROGRAM
8D07101 Renewable Energy

Code and classification of the field of education:
8D07 "Engineering, manufacturing and construction industries"
Code and classification of training areas:
8D071 Engineering and engineering trades
The international standard classification of education
code: 0710
Qualification: doctor of philosophy in the educational program (PhD)
8D07101 Renewable Energy
Training period: 3 years

Astana 2022

Author's team:

1. Mergalimova Almagul Kairbergenovna - PhD, Senior Lecturer, head of the department" Heat Power Engineering"
2. Baubekov Kuat Talgatovich -doctor of technical sciences, associate professor.
3. Ualiev Erlan Bekmuratovich -candidate of technical sciences, senior lecturer.
4. Umirzakov Ruslan Abildaevich-master of technical sciences, senior lecturer

JSC named after S. Seifullin "KATU" No. 932 dated 12.12.2018, the author's team was approved by the order.

Considered at the meeting of the Department of heat power engineering,
Protocol No. 1 of "27" 08.2022

Approved by the Council of the Faculty of energy,
Protocol No. "" _ _ _ _ 2022

Dean of the Faculty of energy_____ Isenov S.S.

Head of the department" Heat Power Engineering" _____ Mergalimova A.K.

Content

1 Passport of the educational program

1.1 The purpose of the educational program:

The main goal of the doctoral educational program "8D07101 **Renewable Energy"** is the formation of the personal qualities of the graduate, as well as general cultural and professional competencies that allow him to carry out professional activities related to the development of theoretical foundations, methods and technical means for converting renewable energy sources, as well as, by the requirements employers and based on the needs of the labour market.

The main objectives of the doctoral educational program **"Renewable Energy"**:

- provide an individual educational trajectory of learning following the specialization chosen by doctoral students;
- to provide a full-fledged and high-quality scientific and pedagogical education, to form professional competence, to deepen theoretical and practical, as well as individual training of doctoral students in the field of energy.
- to promote the acquisition by doctoral students of the most important and sustainable knowledge that provides a holistic perception of the world;
- to develop in students the ability to self-improvement and learn new knowledge;
- train specialists with a high level of professional culture (including the culture of professional communication), who have a civil position, can formulate and solve modern scientific and practical problems, teach at universities, and successfully carry out research and management activities;
- to ensure the development of fundamental courses at the intersection of sciences that guarantee professional mobility;
- ensure the acquisition of the necessary amount of knowledge in the field of university pedagogy and psychology and the acquisition of teaching experience at a university.

The ultimate goal of the program is to prepare, based on the consolidation of the scientific and educational resources of the university, competitive specialists in the field of energy who can take part in the implementation of a technological breakthrough in the economy of the Republic of Kazakhstan.

2 General characteristics of the educational program.

Currently, following some state programs for the development of agriculture, the training of specialists in the EP "**Renewable Energy**" capable of performing research, pedagogical and practical work, which is a set of means, methods and methods of human activity related to the development of theoretical foundations, is very relevant. , methods and technical means of converting renewable energy sources. At the same time, it is very important to train modern highly qualified scientific and pedagogical personnel for the implementation of professional activities, in accordance with the requirements of employers and based on the needs of the labour market. The uniqueness of the educational program lies in the fact that this activity is associated with high risks due to the operation of equipment with high parameters of the working environment (temperature, pressure) and large structures.

Due to the fact that in Kazakhstan 85% of electricity is generated by coal-fired thermal power plants, today to improve the environmental situation in the world, there is

an urgent need to increase the share of energy generated by renewable energy sources. In this regard, the need for training in this EP will be constantly relevant.

The modular educational program "Renewable Energy" was developed in accordance with the National Qualifications Framework and aligned with the Dublin descriptors and the European Qualifications Framework. The educational program is designed on the basis of a modular system for studying disciplines and contains 5 modules that form general cultural and professional competencies.

The modular educational program in the speciality of the master's program "Heat power engineering" provides for the study of the following cycles:

- theoretical training in cycles of basic and major disciplines;
- additional types of training: pedagogical, research practice;
- research work of a doctoral student, including the completion of a doctoral dissertation;
- final state certification in the form of passing the state exam in the speciality and preparing and defending the final work of a doctoral candidate.

The normative term for mastering a modular educational program for the scientific and pedagogical direction of education is 3 years.

The labour intensity of mastering the modular educational program for doctoral students indicated in credits for the entire period of study in accordance with the State Educational Standard of the Republic of Kazakhstan in the direction of training "Renewable Energy", including all types of classroom and independent work of the student, practice, and the time allotted for quality control in full-time education is 180 credits, including:

180 credits for studying academic disciplines,Research practice - 20 credits, teaching practice - 5, doctoral research work - 115 credits115 credits for the final certification**.**

3 Competence model (portrait) of a graduate

3.1 Area ofprofessionalactivity:

The field of professional activity of the graduate is energy as an integral part of technology, which includes a set of means, methods and methods of human activity related to the development of theoretical foundations, methods and technical means for converting renewable energy sources. The objects of the doctoral student's professional activity are power plants, power plants and complexes based on non-traditional and renewable energy sources, as well as power supply systems for rural settlements of agricultural enterprises, transport systems and their facilities.

The field of activity of the graduate of the OP**" Renewable Energy "** is a branch of activity that is associated with the use of renewable energy sources for the production, supply, transportation, storage, transmission and consumption of energy generated from renewable sources.

The objects of professional activity of a doctoral candidate are:

- power plants, power plants and complexes based on non-traditional and renewable energy sources, as well as power supply systems for rural settlements of agricultural enterprises, transport systems and their facilities;
- power plants, power plants and complexes based on renewable energy sources.

- autonomous power complexes as part of a photovoltaic installation with various capacities with a monitoring, storage and backup power supply system;
- heat supply systems with a heat pump;
- solar systems with thermal collectors;
- wind turbine installations with the horizontal and vertical axis of rotation;
- mini-hydroelectric power stations and micro-hydroelectric power stations;

3.2 Types of professional activity:

The types of professional activity of the graduate are:
- scientific research;
- pedagogical;
- operational research;
- production and technological;
- construction;
- organizational - managerial;
- design and engineering.

3.3 General educational competencies

General educational competencies of a doctoral graduate formed as a result of mastering the modular educational program **" Renewable Energy "** :

– own culture of thinking, the ability to generalize, analyze, perceive information, set a goal and choose ways to achieve it;

– be able to logically correctly, reasonably and clearly build oral and written speech;

– willingness to cooperate with colleagues, and work in a team;

– the ability to find organizational and managerial decisions in non-standard situations and the willingness to bear responsibility for them;

– be able to use normative legal documents in their activities;

– strives for self-development, and improvement of their qualifications and skills;

– be able to critically assess their own strengths and weaknesses, outline ways and choose means to develop strengths and eliminate weaknesses;

– be aware of the social significance of their future profession, and have a high motivation to perform professional activities;

– the ability to analyze socially significant problems and processes;

– use the basic laws of natural sciences in professional activities, apply the methods of mathematical analysis and modelling, theoretical and experimental research;

– to realize the essence and significance of information in the development of modern society; owns the main methods, ways and means of obtaining, storing, and processing information;

– have skills in working with a computer as a means of information management;

– the ability to work with information in global computer networks;

– speak one of the foreign languages at a level not lower than spoken;

– own the basic methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, and natural disasters;

– own the means of independent, methodically correct use of methods of physical education and health promotion, ready to achieve the proper level of physical fitness to ensure full-fledged social and professional activities;

3.4 Core competencies

The basic competencies of a doctoral graduate formed as a result of mastering the modular educational program **" Renewable Energy "** :

- conducting research and development in the field of renewable energy, energy use and energy supply;
- development of program plans and methodologies for conducting tests, participating in experiments, conducting observations and measurements, compiling their description and conclusions in the development of modernization and operation of energy equipment based on renewable energy sources;
- conducting a technical justification of the decisions made on the development of renewable energy systems;
- development of mathematical and simulation models for the operation of installations and systems of renewable energy;
- analysis of the state and prospects for the development of renewable energy, using the necessary tools and methods;
- analysis of the state and dynamics of objects of activity of renewable energy;
- the creation of theoretical models that allow predicting the properties and behaviour of objects of activity;
- use of computer technologies for modelling and processing the results of experimental and theoretical studies;
- development of energy-efficient equipment, installations and complexes of renewable energy;
- use of modelling and optimization methods for installations and complexes of renewable energy;
- implementation of fundamentally new processes and complexes of renewable energy installations;
- establishing the potential and reserves of energy saving in the agricultural sectors;
- development of new promising and non-traditional methods of processing technological and natural waters and water preparation;
- the study of physical and chemical processes of water preparation and non-traditional fuels with the wide use of modelling and computer technologies;
- the study of methods for managing the processes of wind flow transfer;
- methods and apparatus for converting various types of renewable energy into thermal energy ;

3.5 Professional competencies

Basic competencies of a doctoral graduate formed as a result of mastering the modular educational program **" Renewable Energy " :**

- development of curricula;
- writing methodological developments;
- conducting training sessions with students;
- introduction of modern forms and methods of teaching.
- organizing the work of a team of performers, making management decisions in the face of different opinions;
- finding a compromise between different requirements (to cost, quality, safety and deadlines) both in long-term and short-term planning;
- assessment of production and non-production costs to ensure a given level of product quality;
- implementation of technical control, testing and quality management in the production process.
- organization of maintenance, repair, installation and testing of technical equipment for renewable energy;
- organization of accounting and regulation of wind and hydropower resources;
- organization of calculations of production estimates, specific costs of renewable energy resources;
- preparation of technical and economic balances of installations, technological processes, sections and the enterprise as a whole;
- energy assessment of wind and hydro resources;
- monitoring and management of energy flows at the enterprise;
- analysis of the production and financial activities of an industrial enterprise of renewable energy;
- organization and management of production and intellectual activities of the workforce of a renewable energy enterprise ;
- control over compliance with production and labour discipline, and life safety requirements; carrying out activities for the environmental safety of the enterprise.
- organization of maintenance, repair, installation and testing of technological equipment for renewable energy;
- making managerial decisions.

1 The base for passing professional practices (all types of practices)

Doctoral students are sent to the productionpractice, according to the agreement with the enterprises that are the base of the practice (individual agreements or collective agreements) in accordance with the order of the rector on the practice. From KATU n. S.Seifullina is assigned practice leaders for each doctoral student.

PhD studentsof this profile are trained in :

- "National Research Institute for Industrial Safety Problems of the Ministry of Emergency Situations of the Republic of Kazakhstan",
- Institute of Energy Research of the National Academy of Sciences of the Republic of Kazakhstan,
- Tomsk Polytechnic University,
- Warsaw University of Technology (Warsaw University of Technology),
- Moscow Power Engineering Institute (Technical University),

also, in the department, where there is a specialized research laboratory on energy problems. On the basis of the laboratory, scientific work is carried out within the framework of priority areas - an effective solution to prioritize tasks in the field of energy.

Doctoral students, also, under individual contracts, undergo internships in any industries and enterprises where there is renewable energy equipment.

5 The structure of the educational program of doctoral studies in the scientific and pedagogical direction of EP 8 D07101 "Renewable Energy"

No. p / p	Name of cycles of disciplines and activities	General labour intensity	
		in academic hours	in academic credits
1	2	3	four
1.	**Theoretical training**	**1350**	**45**
1.1	**The cycle of basic disciplines (DB)**	**750**	**25**
	academic writing	150	5
	Scientific research methods	1 5 0	5
1)	University component		
	Mathematical modelling of energy processes	150	5
2)	Teaching practice	300	ten
2.1	**The cycle of major disciplines (PD)**	**600**	**twenty**
1)	**University component**	**600**	**twenty**
	Methods of marginal energy saving in high-temperature technology	1 5 0	5
	Designs of furnace and burner devices for burning biogas and agricultural waste	150	5
2)	Research practice	300	ten
2	**Research work**	**3690**	**123**
1)	Research work of a doctoral student, including an internship and a doctoral dissertation	3690	123
3)	Additional types of training	-	-
4)	**final examination**	**360**	**12**
	Writing and defending a doctoral dissertation	360	12
	Total	**5400**	**180**

Annexe 3 Description of the basic disciplines

1. Basic information about the discipline:	
Name of the discipline	**Scientific research methods**
2. Number of credits	**5**
3. Prerequisites:	History and philosophy of science Professionally oriented language
4. Postrequisites:	Philosophical problems of technology
5. Competencies:	Mastering the basic theoretical provisions, laws, principles, terms, concepts, processes, methods, technologies, tools, and operations for the implementation of scientific activities. Formation of knowledge about: methods of planning and organization of scientific research; a general methodology of scientific design, creativity, a general scheme for organizing scientific research; conducting scientific research, analysis, and experiments.
6. Author of the course	Chairs:Thermal power engineering
7. Basic literature	Main literature: 1. Ts.R.Zaychik, B.Ts.Zaychik. History and philosophy of science and technology. M: Academic project. 2010 - 275s. 2. Stepin V.S. History and philosophy of science. M: Higher school. 2012 - 275s. 3. Shtanko V.I. Philosophy and methodology of science.Kharkiv. Phoenix Publishing. 2002 - 345s.
8. The content of the discipline. **Methods of scientific research** - the main attention is paid to the problems of the methodology of scientific knowledge, although considerable material has been accumulated in the practice of technical knowledge.	
1. Basic information about the discipline:	
Name of the discipline	**academic writing**
2. Number of credits	**5**
3. Prerequisites:	Professionally oriented language
4. Postrequisites:	Philosophical problems of technology
5. Competencies:	Knowledge and application of scientific research methods, modern methods of searching for scientific information on the topic of scientific research, academic writing; understanding of the meanings of the principles and culture of academic integrity.Use of computer technologies and programs for thermal calculations and processing of research results, application of methods of mathematical analysis and modelling. Possession of the skills of pedagogical activity in the disciplines of the direction of the EP, conduct training sessions with students using modern forms and methods of teaching and develop educational and methodological documentation.
6. Author of the course	Chairs:Thermal power engineering
7. Basic literature	Main literature: 1 Korotkina I. B. Academic writing: process, product and practice. Textbook for universities2015 2 Ts.R.Zaychik, B.Ts.Zaychik. History and philosophy of science and

	technology. M: Academic project. 2010 - 275s.
8. The content of the discipline. Development of relevant competencies among doctoral students aimed at developing the readiness and ability of scientific and pedagogical personnel to implement research projects and present results in writing in accordance with the norms of the international academic community. Acquaintance with the requirements for the design and structure of the presentation of the results of scientific research in scientific articles, dissertations, and patents.	

Annexe 4 Description of major disciplines

1. Basic information about the discipline:	
Name of the discipline	**Methods of marginal energy saving in high-temperature technology**
2. Number of credits	**5**
3. Prerequisites:	Master's disciplines
4. Postrequisites:	
5. Competencies:	Knowledge of the design characteristics and operational features of modern highly efficient energy-saving heat and power equipment based on renewable energy sources.Analyze the modes of operation of thermal power equipment, determine the most rational parameters, and manage the quality and reliability of the functioning of production and energy supply systems based on renewable energy sources.
6. Author of the course	Department of Thermal Power Engineering
7. Basic literature	1. Makarov, A. N. Heat transfer in electric arc and torch metallurgical furnaces and power plants. - St. Petersburg. : Lan, 2014. - 384 p. 2. Kanaev, A. T. Introduction to nanostructural materials science. Astana : Master P o, 2018. - 232 p. 3. Kanaev, A. T. "Optimization of indicators of mechanical properties of steel castings using methods of planning experiments" - Astana. 2013. - 31 p .
8. The content of the discipline. Formation of knowledge among doctoral students: types, scope, design and operational features of high-temperature installations; about the existing methods of marginal energy saving in high-temperature technology, the search for new ways to improve the energy efficiency of high-temperature installations, methods for calculating energy saving and energy efficiency indicators.	

1. Basic information about the discipline:	
Name of the discipline	**Designs of furnace and burner devices for burning biogas and agricultural waste**
2. Number of credits	**5**
3. Prerequisites:	Master's disciplines
4. Postrequisites:	
5. Competencies:	Knowledge of the design characteristics and operational features of modern highly efficient energy-saving heat and power equipment based on renewable energy sources.Analyze the modes of operation of thermal power equipment, determine the most rational parameters, and manage the quality and reliability of the functioning of production and energy supply systems based on renewable energy sources.
6. Author of the course	Department of Thermal Power Engineering
7. Basic literature	1. Gabriel I., Ladner H. Reconstruction of buildings according to the standards of an energy-efficient home. - St. Petersburg .: BVH-Petersburg, 2011. - 478 p.

	eleven. 2. Faist V., Elokhov A. E. Basic provisions for the design of passive houses. - M.: ASV, 2008. - 144 p. 3. Tabunshchikov Yu. A., Brodach M. M., Shilkin N. V. Energy efficient buildings. — M.: AVOK-PRESS, 2003. — 200p.

8. The content of the discipline.

Formation of competencies in the field of combustion of biogas and agricultural waste among doctoral students. Knowledge of the design of furnace and burner devices for usein the production of agricultural products and livestock breeding, new economic psychology focused on resource conservation, waste disposal and decarbonization of energy systems.

1. Basic information about the discipline:	
Name of the discipline	**Mathematical modelling of energy processes**
2. Number of credits	**5**
3. Prerequisites:	Mathematics, Theoretical foundations of heat engineering, Physics, Chemistry.
4. Postrequisites:	Disciplines of doctoral studies
5. Competencies:	Knowledge and application of scientific research methods, modern methods of searching for scientific information on the topic of scientific research, academic writing; understanding of the meanings of the principles and culture of academic integrity.Use of computer technologies and programs for thermal calculations and processing of research results, application of methods of mathematical analysis and modelling.
6. Author of the course	Department of Thermal Power Engineering
7. Basic literature	1 Baklanova O.E. "Mathematical and computer modelling". - Ust-Kamenogorsk: EKSTU, 2013. - 113 p. 2 Baklanova O.E., Kvasov A.I., Khakimzyanov G.S., Shvets O.Ya. Fundamentals of Mathematical Modeling: Textbook. - Ust-Kamenogorsk: EKSTU, 2013. - 126 p. 3 Weinberg M. Mathematical modelling of transport processes. Solution of nonlinear boundary value problems. 2009

8. Content of the discipline

Formation of knowledge, skills and abilities of doctoral students in the application of mathematical methods for modelling and optimizing energy processes for various industrial enterprises. O mastery of methods and techniques of mathematical modelling by doctoral students; conducting a computational experiment; the use of computer technology and computer technology for research and selection of optimal options for installations and systems for such processes.