Renewable Solar Energy (Master)

Saint Petersburg Electrotechnical University "LETI"

Degree or qualification is awarded: **Master**

Language of study: **English**
Mode of study: **full-time**
Duration: **2 years**
Availability of free education: **yes**
Price: **200 000 rubles per year**

Programme webpage at the university website: https://etu.ru/en/study/masters-degree/renewable-solar-energy/

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Master modern solar energy technology and learn the main principles of photovoltaics! While studying at the program, you will gain insight on underlying physical principals and materials science aspects of photovoltaics, solar module development technology, the equipment, design and maintenance of solar power plants.

Master the most cutting-edge field of modern power engineering and build a successful career at international research- and technology-intensive companies!

The program focuses on the latest trends in the field of renewable energy and photovoltaics. Students get acquainted with underlying physical principals and materials science aspects of photovoltaics, solar module manufacturing technology, the equipment involved in design and maintenance of solar power plants. The curriculum pays special attention to the newest solar cell production technique - HIT (Heterojunction with Intrinsic Thin layer). The curriculum also includes basic, specialized and comprehensive courses. The program has been independently certified and awarded the EUR-ACE® label by the European Network for Accreditation of Engineering Education (ENAEE).

The main areas of research at the Photonics Department are the following:

- quantum dot organic LEDs;
- laser and fluorescence emitters based on colloidal nanoparticles;
- solar-blind and visible-blind photodetectors;
- organic solar cells;
- high-performance visible and ultra-violet light emitting diodes (LED);
- production of thin-film silicon carbide solar cells;
- development of multi-junction photovoltaic device structuresand high-performance TCO materials;
- development of modern flexible solar cells with a novel encapsulation technology
- development of processes and equipment for low-cost, wide-scale and high-yield photovoltaic device manufacturing.

Students of the Photonics Department have access to the most modern and complex technological equipment and metrology tools, carry out experiments and gain new skills of operating real metrology devices and technological equipment. Special attention is dedicated to silicon photovoltaics, including the most efficient HIT structures.

Master’s students attend lab classes and carry out research at laboratories of ETU “LETI” partners:

- R&D Center TFTE. TFTE is the research branch of the company Hevel Solar.
- Ioffe Institute. One of the Russia’s biggest research institutes in physics and technology.
- Saint Petersburg National Research Academic University of the Russian Academy of Sciences (Alferov University) is the only University in Russia, which was founded by Nobel Prize laureate in Physics (2000) prof. Zhores Alferov.

Specializations within this programme

Renewable Energy Sources (5 ECTS)

Course «Renewable energy sources» is one of the basic courses of the Master's degree program. Course considers questions of physics and technologies of solar modules. Course «Renewable energy sources» includes the study of the physical foundations of photovoltaic solar energy converters, characteristics of the materials used for their production, principles of modeling of solar cells, advanced production technologies aimed at improving the efficiency of solar energy converters.

Solar Energy Materials (4 ECTS)

Course «Solar energy materials» includes main branches of Condensed Matter Physics and Solid State Optics. The main points of the theory of electronic spectra of solids are discussed, along with the basics of the theory of radiation interaction with matter. The light absorption and other physical phenomena which determine the optical properties of crystalline and disordered semiconductors are considered. Special attention is paid to physical interpretation of studied phenomena, theoretical description and the most important experimental facts.

Micro- and Nanotechnology Processes (4ECTS)

Course «Micro- and nanotechnology processes» considers materials deposition, etching and modifying methods at micro- and nanolevel which used in solid state electronics and integrated circuit components forming. Base processes and equipment used in conventional microtechnology and specific processes, permissive to form structures on molecular level and based on selforganization, selectivity, anisotropy abilities and matrices principle are studied.

Opto-physical Methods of Investigation of Solar Energy Materials (3 ECTS)

The course «Opto-physical methods of investigation of solar energy materials» covers basic optical and spectroscopic methods, techniques and equipment such as light photometry, UV/V spectrometry, Fourier transform infrared spectrometry, Raman spectroscopy, ellipsometry and interferometry, which are widely used in the diagnostics of materials and thin film structures of solar photovoltaics. The course also includes an introductory part dedicated to the fundamentals of geometrical and wave optics, laboratory workshops and seminars.

Diagnostics of Solar Energy Materials and Structures (5 ECTS)

Course «Diagnostics of solar energy materials and structures» is devoted to modern techniques and methods of diagnostics and characterization of materials and structures in microelectronics and photovoltaics. The main techniques used within the microelectronics and photovoltaics are explained. In particular, the subject is focused on the most widely used techniques such as charge-based and probe methods, as well as chemical and physical methods.

Metrology of Solar Cells and Modules (3 ECTS)

Course «Metrology of solar cells and modules» considers the following subjects: «Sunlight, its characteristics» where the sunlight characteristics and methods of indoor light parameters modeling, also a quality monitoring of parameters of sunlight will be considered. «Reference solar cells and their design». The section is devoted to design of reference solar cells, ways of their calibration. «Spectral characteristics of solar cells». In the given section techniques and the equipment for spectral characteristics measurement of thin-film solar cells, including multijunction cells are presented. «Current-voltage characteristics of solar cells». The section acquaints with techniques and the equipment for measurement of the current-voltage characteristics of solar cells and solar modules, as well as specific features of tandem thin-film solar cells modules current-voltage characteristics. «The photoinduced degradation of solar cells». The section acquaints with problems of the photoinduced degradation of thin-film solar cells and its characterization methods.

Technology of Solar Cells and Modules (4 ECTS)

Course «Technology of solar cells and modules» covers the following questions: Prospects of solar energy. Classification of the photoelectric converters of solar energy. Basics of silicon thin-film solar modules production. Main steps of silicon micromorph solar modules production. Quality of gases and materials used for silicon micromorph solar modules production. Basic procedures of fabrication of micromorph silicon solar modules. Substrate choice and preparation procedure. Deposition process of transparent conductive ZnO layer. Laser scribing. Deposition of

photoactive absorbing amorphous and microcrystalline hydrogenated silicon layers. Back-end process: contacts application, edge isolation, lamination process, junction box assembly. Main trends of research for thin-film silicon photoelectric solar energy converters. Production lines for silicon based thin film solar modules. High-tech equipment used in silicon based thin film solar modules production.

Equipment and Automation of Solar Power Stations (4 ECTS)

Course «Technology of solar cells and modules» covers the following questions: Prospects of solar energy. Classification of the photoelectric converters of solar energy. Basics of silicon thin-film solar modules production. Main steps of silicon micromorph solar modules production. Quality of gases and materials used for silicon micromorph solar modules production. Basic procedures of fabrication of micromorph silicon solar modules. Substrate choice and preparation procedure. Deposition process of transparent conductive ZnO layer. Laser scribing. Deposition of photoactive absorbing amorphous and microcrystalline hydrogenated silicon layers. Back-end process: contacts application, edge isolation, lamination process, junction box assembly. Main trends of research for thin-film silicon photoelectric solar energy converters. Production lines for silicon based thin film solar modules. High-tech equipment used in silicon based thin film solar modules production.

Equipment and Automation of Solar Power Stations (4 ECTS)

Course «Equipment and automation of solar power stations» is devoted to studying of the equipment of solar power stations. Photovoltaic modules only represent the basic element of a solar power system. They work only in conjunction with complementary components, such as batteries, inverters, and transformers. Power distribution panels and metering complete the energy conversion process. In the course the characteristics of the equipment of solar power stations are discussed in details.

Laser Technologies and Processing in Manufacturing of Solar Modules (4 ECTS)

Course «Laser technologies and processing in manufacturing of solar modules» contains information on physical fundamentals of laser technologies and architecture of industrial lasers. The requirements for lasers for microprocessing of materials are analyzed. Their main output parameters and features of operation are given. Case studies on applications of lasers for industrial processing of materials (mainly in microelectronics) are described. Separated part is dedicated to use of lasers in manufacturing the thin-film solar panels.

Microprocessor Technology (4 ECTS)

Course «Microprocessor technology» is dedicated to learning of the modern microprocessor families, microcontroller devices construction principles, microprocessor devices programming. During studying students get knowledge about components of the microprocessor systems; learn how to use cross-compilers for the software development in C programming language. Laboratory bench including modern high-efficiency ARM microcontroller and various input/output peripherals is used in the course lessons and laboratory practice.

Computer Technology and Simulation in Electronics (4 ECTS)

Course «Computer Technology and Simulation in Electronics» is devoted to the study and practical application of computer technologies in the field of electronics. Elements of numerical simulation of micro- and nanoelectronic devices. This section discusses the features of solutions of systems of differential equations describing the operation of micro- and nanoelectronic devices. We consider the drift-diffusion and hydrodynamic model. The features of the numerical solution of one-dimensional problems on the basis of MathCAD (MathLAB). Features two-dimensional solutions of problems are considered on the basis of a package FlexPDE and Synopsys. Basics of programming, acquisition and processing of experimental data. Organization software in the form of problem-oriented software packages. The concept of virtual instruments. LabVIEW - a graphical programming system. Programming systems for collecting information. Programming of information processing systems (elements of digital signal filtering, etc.). Organization of distributed software and hardware systems.

Problems of Modern Electronics (4 ECTS)

Course «Problems of modern electronics» is dedicated to introduction of the latest trends and achievements in various promising fields of electronics. Studying of the course is reinforced by practical exercises aimed at acquiring the appropriate skills for formulating and solving problems when creating new components and technologies for nanoelectronics. As a result, students should be able to formulate goals of scientific research and technological development. This course provides a framework for a qualified activity of the graduates in the development of the

field of nanotechnology and hardware components of nanoelectronics.