Curriculum 2018-2020

The Master's Programme in Advanced Energy Solutions provides the education needed by engineers to create the sustainable energy system of tomorrow. The Programme has four majors, each focussing on a different segment of the energy system. In each of the majors, you will be provided a solid theoretical background, complimented with interdisciplinary studies to broaden and deepen the understanding of energy challenges in our society. In all majors there is a focus on industry relevance and opportunities to work with companies and other stakeholders in the energy sector. The programme gives students excellent prospects for employment in energy companies, manufacturing industries and consulting companies. Two of the majors are organized by the School of Engineering (ENG,) one by the School of Chemical Engineering (CHEM) and one by the School of Electrical Engineering (ELEC), as follows:

- Sustainable Energy Systems and Markets (ELEC)
- Sustainable Energy in Buildings and Built Environment (ENG)
- Sustainable Energy Conversion Processes (ENG)
- Industrial Energy Processes and Sustainability (CHEM)

Overall programme learning objectives

- Understand the fundamentals of energy systems
- Be able to take a holistic view to understand dependencies across large energy systems
- Analyze and evaluate existing and future challenges in the field of energy, and the role of energy technologies and processes in addressing these challenges.

Description, learning outcomes and the structure of the majors

Sustainable Energy Systems and Markets

A reliable and affordable energy system is the basic requirement of a modern society. Today, energy systems face challenges with the flexible integration of different energy forms (power, heat, fuels) and with the increasing complexity of the systems due to distributed power generation and emergence of active producer-customers, i.e. prosumers. Integrating intermittent renewable sources, like solar, wind and wave energy, into the energy system is one of the main challenges of our sustainable future. This major offers a basic understanding of energy systems, the main challenges faced by our energy solutions today and possible ways towards a sustainable future.

The major offers a firm theoretical base as well as practical tools and skills needed by engineers working in the field of energy systems. In order to prepare students for understanding complex and multidisciplinary problems in the field, the major is designed to be flexible. Courses include theoretical considerations, experimental work and industrial applications. The major prepares students for current and future challenges faced by energy companies, manufacturing industry, consulting companies and society. Students are well-prepared to pursue doctoral studies.

Learning outcomes

Upon completion of the Major, the student will attain the following learning outcomes:

- Understand the fundamentals of energy systems
- Have a holistic view which enables analyzing complex dependencies in vast energy systems
- Optimize and develop energy systems, taking into account different energy forms
- Understand the role of various parties in energy markets
- Develop applications for energy efficiency and sustainability
- Analyze and evaluate existing and future challenges in the field of energy systems

Degree structure

The master's degree consists of the major studies, elective studies and a master’s thesis.

The major studies (65 cr) are divided into programme common courses (15cr), major common courses (25cr) and advanced studies (25cr). The programme common courses (15cr) and major common courses (25cr) are compulsory for all and are completed in the beginning of the studies. In the advanced studies (25 cr) students can choose from a variety of courses. Students may freely choose courses from the list given as long as course specific prerequisites are followed (the prerequisites are listed in the course descriptions in WebOodi).

For elective studies (25 cr) students can choose courses offered by Aalto University, including other courses under the Advanced Energy Solutions programme. Please see the possible major specific example study paths for suggestions.

Professors of the programme have prepared suggestions for how to create meaningful combinations of courses for dedicated fields of specialization. These ready-made study paths will help you to choose courses for your advanced and elective studies.

Students may also complete a certain master level minor in addition to the major studies. Please find minors Aalto University offers from Aalto University minor's guide.

Sustainable Energy in Buildings and Built Environment

Already today, a great majority of people are living in cities and urbanization is a continuing trend. Developing energy efficient buildings and cities is a huge current challenge, when at the same time all solutions should also achieve healthy, comfortable and productive indoor environments. At the moment, buildings are responsible for 40% of final energy consumption and about 50 % of electricity consumption. For
this reason, nations in Europe and beyond have awoken to the need to reduce the use of energy in buildings. In the short term, all new buildings should be nearly zero energy buildings by the year 2020. In the next phase, the EU 2050 roadmap defines that by 2050, the equivalent CO₂ emission from the building sector should be reduced by around 90% compared to the 1990 level.

The candidates in this study line will gain specific knowledge in sustainable energy technologies. The major offers the theoretical basis and practical skills that are required in designing projects and the development of novel technologies and services for energy efficient buildings and communities. The major will offer advanced courses on efficient use of energy in the fields of building technology and services, and design of heating, ventilation and air conditioning (HVAC) systems. The specialization of the major includes specification of performance of building HVAC systems and indoor environmental quality. The major prepares students for current and future challenges in construction and building service industries.

**Learning outcomes**

Upon completion of the Major, the student will:

- Have an understanding of interdisciplinary aspects of energy efficiency
- Have an understanding of the methods to improve energy efficiency
- Will be aware of how to utilize renewable energy sources in buildings
- Will be able to optimize building systems and develop services to improve energy efficiency
- Have an understanding of how the entity of building design and HVAC system influences upon the indoor environment
- Have an understanding of design methods and appropriate simulation and optimization tools

The Advanced HVAC course package (45 cr.) provides the qualification to be a responsible designer of exceptionally demanding HVAC projects in Finland.

**Degree structure**

The master's degree consists of the major studies, elective studies and a master's thesis.

The major studies (65 cr) are divided into programme common courses (15 cr), compulsory courses (15 cr) and advanced studies (35 cr). The programme common courses and compulsory major courses are compulsory for all and completed in the beginning of the studies. In the advanced studies students can choose from a variety of courses. Students may freely choose courses from different topic groups as long as course specific prerequisites are followed (the prerequisites are listed in the course descriptions in WebOodi).

For elective studies (25 cr) students can choose courses offered by Aalto University, including other courses under the Advanced Energy Solutions programme. Please see the possible major specific example study paths for suggestions.

Students may also complete a certain master level minor in addition to the major studies. Please find minors Aalto University offers from Aalto University minor's guide.

**Sustainable Energy Conversion Processes**

Provision of energy has a major impact on the environmental performance of society. Understanding principles and the effects of different energy conversion pathways and their interaction is of utmost importance to operating the energy system effectively, while minimizing environmental impact. This major provides understanding of different aspects of energy conversion and storage. The major covers the fields of heat and power processes, energy conversion technologies and utilization of natural resources as energy carriers. In this major the student can also focus on computational methods. Renewable energy generation technologies as well as conventional thermal power processes are covered. Students in the major gain a strong education in energy technology as well as a deep knowledge of the advanced field in the discipline.

The major offers a firm theoretical base as well as practical tools and skills needed by engineers working in the field of energy. In order to prepare students for understanding complex and multidisciplinary problems in the field, the major is designed to be flexible. Courses include theoretical considerations, experimental work, industrial applications, and first-hand experience. The major prepares students for current and future challenges faced by energy companies, manufacturing industry, consulting companies and society. Students are well-prepared to pursue doctoral studies.

**Learning outcomes**

Upon completion of the major, the student will be able to:

- Understand existing and emerging biomass sources for sustainable energy use
- Apply proper tools and software to simulate and design energy conversion processes
- Analyze systems using the principles of thermodynamics, energy balances, and heat and mass transfer
- Evaluate different energy conversion methods, their restrictions and applicability to various situations
- Create solutions for energy industry

**Degree structure**

The master's degree consists of the major studies, elective studies and a master’s thesis.

The major studies (65 cr) are divided into programme common courses (15 cr), major common courses (20 cr) and advanced studies (30 cr). The programme common courses (15 cr) are compulsory for all. For the major common courses (20 cr) students may select from a number of courses with some restrictions. Both the programme common courses and major common courses are completed in the beginning of the studies. In the advanced studies (30 cr) students can choose from a variety of courses. Students may freely choose courses from different topic groups as long as course specific prerequisites are followed (the prerequisites are listed in the course descriptions in WebOodi).
For elective studies (25 cr) students can choose courses offered by Aalto University, including other courses under the Advanced Energy Solutions programme. Please see the possible major specific example study paths for suggestions.

Professors of the programme have prepared suggestions for how to create meaningful combinations of courses for dedicated fields of specialization. These ready-made study paths will help you to choose courses for your advanced and elective studies.

Students may also complete a certain master level minor in addition to the major studies. Please find minors Aalto University offers from Aalto University minor's guide.

Industrial Energy Processes and Sustainability

Energy consumption in industry has a great impact on the sustainability of energy systems and society as a whole. Understanding, managing and designing energy intensive industrial processes efficiently is a key issue in the field of energy. This major provides an understanding of the energy and process industry, its main challenges and the possibilities for development. The major addresses engineering knowledge involved in energy intensive industrial processes, heat and power processes, biomass conversion and energy efficiency in industry. Students in the major gain a strong education in energy technology as well as a deep knowledge of advanced fields in this discipline.

The major offers a firm theoretical base as well as practical tools and skills needed by engineers working in the field of industry. In order to prepare students for understanding complex and multidisciplinary problems in the field, the major is designed to be flexible. Courses include theoretical considerations, experimental work, industrial applications, and first-hand experience. The major prepares students for current and future challenges faced by energy companies, manufacturing industry, consulting companies and society. Students are well-prepared to pursue doctoral studies.

Learning outcomes

Upon completion of the major, the student will be able to:

- Understand existing and emerging biomass sources for sustainable industrial use
- Understand the theory, design and operation of energy related industrial systems
- Understand fundamentals of bio-based thermochemical processes
- Apply proper tools and software to simulate and design energy-related processes
- Analyze systems using the principles of thermodynamics, energy balances, and heat and mass transfer
- Analyze energy efficiency of industrial processes and systems
- Create solutions for energy intensive industry

Degree structure

The master’s degree consists of the major studies, elective studies and a master’s thesis.

The major studies (65 cr) are divided into programme common courses (15 cr), major common courses (20 cr) and advanced studies (30 cr). The programme common courses (15 cr) are compulsory for all. For the major common courses (20 cr) students may select from a number of courses with some restrictions. Both the programme common courses and major common courses are completed in the beginning of the studies. In the advanced studies (30 cr) students can choose from a variety of courses. Students may freely choose courses from different topic groups as long as course specific prerequisites are followed (the prerequisites are listed in the course descriptions in WebOodi).

For elective studies (25 cr) students can choose courses offered by Aalto University, including other courses under the Advanced Energy Solutions programme. Please see the possible major specific example study paths for suggestions.

Professors of the programme have prepared suggestions for how to create meaningful combinations of courses for dedicated fields of specialization. These ready-made study paths will help you to choose courses for your advanced and elective studies.

Students may also complete a certain master level minor in addition to the major studies. Please find minors Aalto University offers from Aalto University minor's guide.