Linnæus University

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Programme syllabus

Faculty of Technology

Hållbara energiprocesser och system, masterprogram, 120 högskolepoäng

Sustainable Energy Processes and Systems, master programme, 120 credits

Level
Second Level

Date of Ratification
Approved by Faculty of Technology 2017-09-08

Revised 2021-12-10

The programme syllabus is valid from autumn semester 2022

Prerequisites
General entry requirements for second level studies and specific entry requirements:

- Bachelor of Science in Chemical Engineering, Mechanical Engineering, Energy Technology, Environmental Technology, Civil Engineering, Material Science or the equivalent.
- English 6 or the equivalent.

Description of Programme

The programme is intended to advance students' knowledge of energy technology, with focus on renewable energy. It prepares students for a professional career in the industry or in the public sector, as well as for further studies at the doctorate level.

The programme aims to advance students' knowledge about what capacity and technology we have for renewable energy in the form of electricity, heat or cooling, as well as to introduce students to relevant methods for research and investigation. The programme is primarily intended as a preparation for a career as an analyst, environmental controller, consultant or similar, in the private and public sectors alike. The programme also gives professional engineers an opportunity to advance their competence in the field.

Objectives

Central degree goals according to the Higher Education Ordinance

Knowledge and understanding

For a Degree of Master (two years) students shall:

- demonstrate knowledge and understanding of their main field of study, including both general knowledge of the field and substantially deepened knowledge of certain parts of the field, along with an advanced insight into current research and development work; and
- demonstrate advanced methodological knowledge of their main field of study.

Skills and abilities

For a Degree of Master (two years) students shall:

- demonstrate an ability to critically and systematically integrate knowledge and to analyse, assess and handle complex phenomena, issues and situations, even when limited information is available,
- demonstrate an ability to critically, independently and creatively identify and formulate questions; to plan and – using appropriate methods – perform qualified tasks within specified time limits, thus contributing to knowledge development; and to evaluate this work,
- demonstrate an ability to clearly present and discuss their conclusions and the knowledge and arguments upon which they are based, in dialogue with different groups, in speech and in writing, in national and international contexts, and
- demonstrate skills required to participate in research and development work or to work independently in other qualified contexts.

Judgement and approach

For a Degree of Master (two years) students shall:

- demonstrate an ability to make assessments in their main field of study, taking relevant scientific, social and ethical aspects into account, and demonstrate an awareness of ethical aspects of research and development work,
- demonstrate insight into the potential and limitations of science, its role in society and people’s responsibility for how it is used, and
- demonstrate an ability to identify their need of further knowledge and to take responsibility for their knowledge development.

Programme specific goals

Knowledge and understanding

For a Degree of Master (two years) students shall:

- demonstrate general knowledge of and insight into the societal need for an energy supply system based on ecological, economic and social sustainability
- demonstrate general knowledge concerning technical and environmental aspects of renewable energy production.

Skills and abilities

For a Degree of Master (two years) students shall:

- demonstrate an ability to plan and execute independent projects in the area of renewable energy production, and
- demonstrate an ability to present problems, analyses and results in a professional manner, using written reports as well as oral presentations.

Judgement and approach

For a Degree of Master (two years) students shall:

- demonstrate an ability to approach society's energy supply system from a holistic perspective; that is to assess the relevance and applicability of different kinds of plants or technological solutions in relation to the system as a whole.

Content

Programme overview

There is a programme coordinator who has overall responsibility for the programme. The programme consists of a number of predefined courses, providing the knowledge base needed to meet the programme objectives.

The programme starts with one course on sustainable energy supply, where the students are introduced to different techniques for renewable energy production, and one on what factors affect the spread of innovations for sustainable environmental design, and how such innovations can be promoted. In the course on environmental analysis methods, different environmental paradigms and tools for analysis used to support environmental decisions are dealt with. The course on scientific theories and methods teaches the students to identify, formulate and describe scientific research questions, skills that are subsequently used in the course on project methodology, where the students plan and report on a major investment project. National and international legal principles and norms, as well as social and political aspects of sustainable development are dealt with in the course on environmental law. The course on waste as a resource introduces different techniques for and applications of recycling of residual products, such as energy production or refinement into other products. Students with a background in chemistry, with at least 15 credits in chemistry/chemical engineering, may instead choose to take the introductory course on conversion processes in biofuel production, in which different techniques and applications for utilization of residual products are studied from a chemical point of view.

The second year starts with a semester with mainly elective courses; 22.5 credits in total are elective. Students who wish to study abroad may usefully do so in this third semester. The semester starts with a mandatory course on probability theory and statistics, in which the students learn to understand and use basic statistical concepts.

Students who chose the course "Introduction to Conversion Process in Biofuel Production" in the first year can usefully choose the courses "Chemical and Thermochemical Conversion of Biomass" and "Biochemical Conversion with Environmental Biotechnology", which offer a specialisation in the respective field. They can also usefully choose the course "Combustion Technology", where they learn about the most common techniques and equipment used in combustion, or the course "Assessment of Biomass Resources", which looks at possible biomass assets for energy production and the potential for using such assets.

Students who do not have 15 credits in chemistry/chemical engineering and who did not

take the course “Introduction to Conversion Process in Biofuel Production” in the first year, should instead choose the course “Industrial Logistics”, dealing with the definitions, concepts, history, strategies and organization of logistics. They may also choose “Assessment of Biomass Resources” (see above) or “Life Cycle Analysis”, where different products’ and service systems’ natural resource utilization and environmental impact are studied.

Other courses may be chosen in consultation with the programme coordinator.

The final independent project aims at giving the student the skills needed to independently conduct a project over a whole semester. The focus of the independent project is determined by the orientation of the elective courses chosen by the student. Only students with 15 credits in chemistry/chemical engineering, who have taken the course “Introduction to Conversion Processes in Biofuel Production” and either of the courses “Chemical and thermochemical conversion of biomass” or “Biochemical Conversion with Environmental Biotechnology” will be allowed to conduct a project based on chemical/biochemical laboratory work.

The courses in the programme may change order.

Courses in the programme
*marks main field course

Year 1:
Sustainable Energy Supply* (7.5 credits, G1N)
This course gives a general introduction to the different technologies that are available today for production of different commercial energy carriers. It also covers nuclear power, even though this technology is not considered sustainable, since the fuel supply is limited.

Diffusion of Innovations for a Sustainable Built Environment (7.5 credits, A1N)
This course deals with different theories on the spread of innovations and their applications in the built environment. The development of a sustainable built environment relies on a wide use of resource effective innovations. In order to design effective interventions, it is important to understand the process through which innovations develop and spread in society, and what affects possible users’ decisions.

Environmental Analysis Methods (7.5 credits, A1N)
This course deals with different environmental paradigms and analytical tools for supporting environmental decisions, basic concepts relevant for energy analysis and environmental assessment, and methods to evaluate the impact of the built environment on energy and environment.

Scientific Theories and Methods* (7.5 credits, A1N)
This course deals with academic writing complying with international standards for scientific publication. It also presents and discusses relevant scientific issues within the field of technology. It serves as a preparation for the course “Project Work and Methodology”, as well as for the independent project, in that students get to practise designing experiments, choosing methods, and determining aim and scope, as well as justifying their choices.

Laws of Sustainable Development and Energy* (7.5 credits, A1N)
This course covers fundamental legal norms in environmental legislation, trade, trade

legislation and legislation concerning human rights, nationally and internationally.

Introduction to Conversion Processes in Biofuel Production* (7.5 credits, A1N)
This course gives an introduction to the ways in which biomass can be converted into biofuel, and what environmental impact this may have. Different kinds of procedural equipment, unit operations and reactors, along with their respective functions, are introduced and discussed. This course requires 15 credits of chemistry/chemical engineering.

Waste as Resource* (7.5 credits, A1N)
This course presents the ways in which biomass can be converted into biofuel, and what environmental impact this may have. It introduces different types of systems, techniques and applications in which residues and by-products can be used for energy production or refinement into other products.

Project Work and Methodology* (15 credits, A1N)
This course provides knowledge about project work and methodology with the purpose of being used in different parts of the energy supply chain. It provides the knowledge needed to be able to plan and execute a major project on energy systems and planning.

Year 2:
Probability Theory and Statistics (7.5 credits G1F)
This course is an introduction to mathematical statistics, comprising basic probability theory and statistics theory. Probability theory constitutes the basis of the course, introducing basic concepts such as *independence*, *condition*, *expectation* and *variance*.

22.5 credits chosen from the following courses. Other courses may be chosen in consultation with the programme coordinator.

Assessment of biomass resources (for energy)* (7.5 credits A1N)
This course deals with potential biomass assets for energy production, and our capacity to use such assets. Students get to read about, understand and critically assess our capacity as well as conclusions accounted for in reports on investigations concerning biomass assets for energy production.

Life Cycle Analysis (LCA)* (7.5 credits A1N)
This course deals with LCA of different products and service systems, all the way from the extraction of raw material to the completion of a finished product, focusing on the use of natural resources and environmental impact.

Industrial Logistics* (15 credits A1N)
This course deals with logistics as a specific approach, along with distribution, delivery service, production logistics, materials and production management, and material purchase and supply.

Students who have 15 credits in chemistry/chemistry technology, along with the course “Introduction to Conversion Processes in Biofuel Production” (7.5 credits, A1N) can also choose among the following courses:

Combustion Technology* (7.5 credits A1N)
This course aims to provide a basic understanding of the combustion process in terms of simple chemistry, heat and mass transport. The course also provides a basic understanding of the generation of pollution, and gives a general introduction to different kinds of combustion plants.

Biochemical Conversion with Environmental Biotechnology* (7.5 credits A1F)
This course deals with the conversion of biological matter to biofuel; technical solutions, process modelling, process control and process management in production of biofuel, and storing of biomatter for this purpose.

Chemical and Thermochemical Conversion of Biomass* (7.5 credits A1F)
This course deals with production paths for, and physical and chemical characteristics of, different kinds of biofuel, as well as with the concept of biorefinery. Focus lies on chemical or thermochemical conversion of biomass.

Independent Project* (30 credits A2E)
The aim of this course is to give the student the skills needed to independently conduct a project. The student is expected to demonstrate an ability to apply knowledge acquired in preceding courses, and, in doing so, define a problem, conduct an investigation, assess and critically analyse results in light of previous knowledge, and present results in a clear manner. To conduct a chemical laboratory project is only possible for students who have 15 credits in chemistry/chemical engineering, and who have taken the course “Introduction to Conversion Processes in Biofuel Production” along with one of the courses “Chemical and Thermochemical Conversion of Biomass” and “Biochemical Conversion with Environmental Biotechnology”.

Societal relevance
As stated in the above descriptions, the programme contains several project-oriented courses. All projects are chosen in consultation with companies in the local or regional area. This means that students will face problems relevant to the industry, and that they will also have to present their suggested solutions to industry representatives. In this way, students are prepared for a future professional role.

Internationalisation
Students who wish to study abroad may do so in the third semester, taking two optional courses along with mathematical statistics at the foreign seat of learning. Alternatively, the student can choose to conduct their independent project abroad, in the fourth semester.

Programme perspectives
Sustainable Development and Gender:
Education in the field of renewable energy is based on a sustainability approach, where perspectives on class, gender, global resource management and internationalisation constitute consistent themes in most courses.

Diversity and internationalisation:
The diversity perspective is automatically included as part of those courses that are offered in the international market.

Quality Development

There is a reference group linked to the education in bioenergy engineering, with representatives from the industry, the subject and the student group. Quality aspects of the programme are continuously discussed in this reference group.

Evaluation is conducted partly through continuous course evaluations and partly through a special programme evaluation at the end of the programme. The results of these evaluations are discussed with the subsequent student group, the next time a course or the programme starts.

Degree Certificate

After completing their studies in accordance with the requirements stated in the Higher Education Ordinance and in Linnaeus University's local Degree Ordinance, the student may apply for a degree. Students who have completed the programme may obtain the following degree:
A student who holds a Bachelor of Science or an equivalent qualifying degree may receive:
Master of Science (120 credits) with specialization in Sustainable Energy Processes and Systems
Main field of study: Bioenergy Technology

The degree certificate is issued in two languages (Swedish and English). A Diploma Supplement in English is enclosed with the degree certificate.

Other Information

The programme comprises study visits, excursions, study tours and other similar mandatory components which may entail a cost for the student.