



## Programme syllabus

Faculty of Technology

Förnyelsebara elkraftsystem, masterprogram, 120 högskolepoäng  
Renewable Electric Power Systems, Master Programme, 120 credits

### Level

Second Level

### Date of Ratification

Approved 2017-09-08

Revised 2020-09-11 by the Faculty Board within the Faculty of Technology

The programme syllabus is valid from autumn semester 2021

### Prerequisites

General entry requirements for second-cycle studies and specific entry requirements:

- Bachelor Degree in Engineering/Science/Technology
- Electrical Engineering at least 15 credits or Energy Technology at least 15 credits including 7,5 credits in Electrical Engineering or 7,5 credits Electric Power Engineering or equivalent
- Mathematics at least 15 credits including Calculus 1, 7,5 credits (1MA402, 1MA132), and Vector Geometry, 7,5 credits (1MA403, 1MA133), or equivalent
- English B/English 6 or equivalent

### Description of Programme

The program provides profound knowledge of electricity from renewable sources with essential elements of electrical power systems and may lead to occupational activities in industry or the public sector as well as for postgraduate studies in the fields of electrical engineering, electric power systems or energy technology.

The program aims to deepen students' knowledge of the conditions and technologies for electricity from solar, wind and water, as well as the particular challenges that this imposes on power systems. It also aims to introduce students to relevant research methods.

The program primarily prepares for a professional activity as investigator, consultant or permit assessor in the private sector as well as in public administration. The program also offers existing engineers with a bachelor's degree or college degree the opportunity to deepen and increase their skills in the field.

### Objectives

*Knowledge and understanding*

For a Degree of Master (Two Years) students must

- demonstrate knowledge and understanding in their main field of study, including both broad knowledge in the field and substantially deeper knowledge of certain parts of the field, together with deeper insight into current research and development work; and
- demonstrate deeper methodological knowledge in their main field of study.

### *Skills and abilities*

For a Degree of Master (Two Years) students must

- demonstrate an ability to critically and systematically integrate knowledge and to analyse, assess and deal with complex phenomena, issues and situations, even when limited information is available;
- demonstrate an ability to critically, independently and creatively identify and formulate issues and to plan and, using appropriate methods, carry out advanced tasks within specified time limits, so as to contribute to the development of knowledge and to evaluate this work;
- demonstrate an ability to clearly present and discuss their conclusions and the knowledge and arguments behind them, in dialogue with different groups, orally and in writing, in national and international contexts; and
- demonstrate the skill required to participate in research and development work or to work independently in other advanced contexts.

### *Judgement and approach*

For a Degree of Master (Two Years) students must

- demonstrate an ability to make assessments in their main field of study, taking into account relevant scientific, social and ethical aspects, 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 developing their knowledge.

## **Programme-specific objectives**

### *Knowledge and understanding*

For a Master degree the student shall

- demonstrate comprehensive knowledge and understanding of the societal need for an ecologically, economically and socially sustainable electricity supply
- demonstrate comprehensive knowledge regarding the technical and environmental aspects of renewable electricity production and the connections to energy supply

### *Skills and abilities*

For a Master degree the student shall

- demonstrate skills in formulating and using tools and methods to adapt and / or improve systems for electric power generation with renewable energy sources

### *Judgement and approach*

For a Master degree the student shall

- demonstrate the ability to see society's electricity supply from a holistic

perspective, i. e. assess various installations' or technical solutions' relevance and applicability with respect to society's goals for economically, socially and ecologically sustainable development

## Content

### *Programme overview*

The programme has a programme coordinator who has the overall responsibility for the programme. A reference group is tied to the programme in renewable electric power systems, with representatives from industry, the subject electrical engineering and other related subjects, as well as the students. The programme consists of a number of predefined classes that together provide the knowledge base that corresponds to the expected learning outcomes.

The issue of electricity from renewable sources is one of today's main challenges. In many countries, the need for local electricity generation is high, while greenhouse gas emissions globally need to be significantly reduced. Solar, wind, hydropower or bioenergy can be solutions for both electric power and energy supply, which can be selected based on local conditions.

In many countries an additional aspect is that the electricity grid is in great need of modernization. At present, it is a major challenge to be able to handle varying sources such as electricity from solar cells and wind turbines, both in terms of cable capacity and storage capacity. The smart grid is the solution where demand and generation can be matched by means of smart communication.

The program is based on electrical engineering with essential elements of renewable energy, communication and automatic control. This means that students will gain a broad knowledge base and a good overview of the entire field regarding electric power systems and renewable energy. Students are given the opportunity to specialize by means of two elective courses and the degree project.

The first semester consists of two introductory courses, on electric power systems and on renewable energy. The courses are mandatory if the student has not taken them before, to ensure that students without a background in energy systems take the introductory course for renewable energy and that students without a background in electric power engineering study the introductory course in electric power systems. In addition to these, a mathematics course, multivariable analysis and vector analysis, as well as a first immersion course on electricity from renewable sources are included.

During the second semester, students will continue to deepen their knowledge in electrical power systems including smart grids, as well as in estimation theory (statistical signal processing) concerned with smart network management. A project course on electrical power systems provides the opportunity to implement the theoretical knowledge, and the course Legislation on sustainable development and energy is taken which provides an insight into the demands made by society in terms of environmental impact.

Semester three offers the opportunity to choose courses for 15 credits, both must be at the advanced level. In parallel with this, the knowledge of electricity and energy systems is further enhanced by the students studying a course Automatic Control. A course on research methodology and planning of the degree project is being taken.

During the fourth semester, the degree project (thesis) course of 30 credits is done, which is on advanced level.

### *Programme Courses*

*\* marks the main field of study*

## Semester 1:

Electric Power Systems, undergraduate level \* (7.5 credits, G1N), is compulsory within the program and provides an introduction to the power grid, three-phase system and load issues. Students who have already taken this or a similar course can replace it with an optional course in consultation with the program coordinator.

Sustainable energy supply, undergraduate level (7.5 credits, G1N), is compulsory within the program and provides an introduction to renewable energy and biofuels in the world. Students who have already completed this or a similar course can replace it with an optional course in consultation with the program coordinator.

Multivariable calculus and vector calculus, undergraduate level (7.5 credits, G1F), is compulsory within the program. The course deals with gradient integrals and partial derivatives.

Electricity from renewable sources, advanced level \* (7.5 credits, A1N), is compulsory within the program. The course deals with renewable sources, solar, wind and hydropower, generators and converters.

## Semester 2:

Estimation theory, advanced level \* (7.5 credits, A1N) provides basic knowledge of static signal processing.

Legislation on sustainable development and energy, advanced level (7.5 credits, A1N) deals with environmental legislation with application energy systems.

Electric power and smart grid, advanced level \* (7.5 credits, A1N), is mandatory within the program. In the course HVAC and HVDC systems, the quality of power grids, electricity storage and smart grids are considered.

Project course in Renewable Electric Power Systems, Advanced Level \* (7.5 credits, A1N), provides the opportunity to implement theoretical knowledge of electrical power systems, automatic control or communication through simulations, calculations or constructions and measurements.

## Semester 3:

Automatic Control, undergraduate level \* (7.5 credits, A1N) An introductory course in Automatic Control is mandatory within the program. A mathematical description of dynamic systems and concepts such as stability is covered. Students who have already taken this course can replace it with an optional course in consultation with the program coordinator.

Scientific Theories and Methods, advanced level (7.5 credits, A1N), Scientific theories and methods give the student knowledge to identify, formulate and describe scientific issues.

In addition, students take two elective courses (totalling 15 credits), at advanced level, and in this way they can specialize or profile themselves in the field.

## Semester 4:

The programme's fourth semester consists entirely of independent work (degree project) carried out in the main field. The independent work \* comprises 30 credits at advanced level (A2E).

Courses in the programme can be replaced by equivalent courses within the field, in consensus with the program coordinator. The program coordinator will make sure that the program's objectives and requirements are still met. The pre-requisites for courses as well as the local rules for the Linnaeus University degree must always be met.

#### *Societal relevance*

Renewable energy is one of today's major challenges for all societies, both in Sweden and in other countries. In addition, there are major development needs and opportunities in electric power systems with a larger share of renewable sources. Students receive an education that focuses on a broad understanding of this challenge and the different advantages and disadvantages. The programme also focuses on adapting appropriate solutions to local conditions, and the students gain experience of proposing and evaluating concrete solutions where a holistic approach is needed.

As stated in the course descriptions above, the programme includes several project oriented courses. Project assignments may be chosen in consultation with businesses and municipal organizations in the local area or region. This means that students are faced with problems relevant to industry or municipality and also present their proposals for solutions to representatives for these. This helps prepare students for a future profession.

There is an increased need for skills to plan future energy and electric power systems. Students can find employment in business, in both large companies and smaller, or as consultants. Moreover, local organizations or agencies can have use of our students' knowledge.

#### *Internationalization*

The programme is an international master programme and deemed to be of particular interest to students from other continents. Electric power systems and electricity from renewable sources are issues that are important globally.

Those students who wish to pursue part of their studies abroad can do so either in the third semester, presuming that two courses equivalent to Automatic control and Scientific methodology are taken at the university abroad. In addition to this, the programme's third semester opportunity for students to freely choose two courses, which thus can be made at any university. Alternatively, students may choose to implement their degree project during the fourth semester at another university in Sweden or abroad.

#### *Scope of Programme*

Sustainable development and gender

Education in the field of renewable energy is based on a sustainability point of view where class perspectives, gender perspectives, global resources management and an international perspective are common themes e.g. in the course Sustainable energy supply. Moreover, in the courses Electricity from renewable sources and Electric power and smart grids sustainability is one of the preconditions.

### Equal opportunities

A diversity perspective is included automatically as part of the courses offered on the international market. The project course includes a part where the students not only present themselves but also describe the situation in their homelands or regions, which contributes to the students' understanding of the situation in other countries and cultures.

### Broadened knowledge perspective (formation)

The programme puts the need for electricity, and techniques for its production, in a context of global opportunities and local conditions. The programme includes reflecting on the role of technology in society and how it can contribute to a more sustainable way of living.

### Entrepreneurial approach

The programme puts the need for energy and electricity, and the corresponding technologies, in a context of global opportunities and local conditions. It makes it easier for students to see different possibilities, such as for local enterprise, but also links to global opportunities. Project planning is included in several courses, e.g. in the project course and in the research methodology course. Finally, economic sustainability is an integral part of sustainable energy and electricity supply. Said aspects contribute to an entrepreneurial approach.

## Quality Development

A reference group is linked to the renewable electric power systems programme, with representatives from industry, from the subject electrical engineering and related subjects as well as the student group. Quality aspects of the programme are continuously discussed in this group. Evaluation is done through continuous course evaluations, and in the end of the programme through a special programme evaluation. The results of these evaluations are discussed with the students at the start of courses and the programme.

## Degree Certificate

After completing programme studies, corresponding to the requirements expressed in the Higher Education Ordinance degree order as well as Linnaeus University degree order, the student may apply for a degree. Those who have completed the programme may obtain the following degree:

Filosofie masterexamen med inriktning mot förnyelsebara elkraftssystem  
Huvudområde: Elektroteknik,

Master of science (120 credits) with specialization in renewable electric power systems  
Main field of study: Electrical Engineering

Student som innehar en Teknologie kandidatexamen kan erhålla:

Teknologie masterexamen med inriktning mot förnyelsebara elkraftssystem  
Huvudområde: Elektroteknik

Master of science (120 credits) with specialization in renewable electric power systems  
Main field of study: Electrical Engineering

The degree certificate is bilingual (Swedish/English) and accompanied by a Diploma Supplement (in English).

## Other Information

The programme contains mandatory elements, which may result in certain expenses to be paid for by the students themselves.

