Programme description (KTHEGI)

Programme name
Energy Technology and Systems (Energiteknik och -system)

Subject area

The doctoral programme’s overall purpose and learning outcomes
The aim for the postgraduate education in the program is that the doctoral students should become independent researchers with expertise in the research area within their field, that should make it possible to be admitted to postdoc employments at well-renowned universities anywhere in the world, with the postgraduate education as a foundation.

The doctoral student should after completed studies be able to:
- formulate concrete research issues within the energy field.
- use scientific methods and provide new knowledge through own scientific studies
- critically analyse and evaluate applied methods and results from own and others'scientific studies
- present and discuss research results in science community.
- describe and explain theories and empirical results within his research domain.
- identify need for new knowledge
- initiate and lead research.
- present research in an pedagogical way outside the science community and in educational situations
- assess ethical aspects of his/her own research and act from these

The doctoral programme’s size and recruitment
The doctoral programme in Energy and environmental systems is estimated to have about 60 doctoral students, which corresponds a recruitment and examination rate of about 15 doctoral students per year.

The program is primary directed towards recruiting Swedish and foreign Master of Engineering/M.Sc. with an Energy engineering specialisation (or the equivalent). Due to the multi-disciplinary nature of the subject, students with other technical or non-technical background could be considered in certain projects.

Recruitment of doctoral students should normally take place through advertisements in national and/or international press. Students with good research potential that are identified in the Master's education can be urged to search such employments.

Doctoral students can also be recruited among people who have been offered scholarships or salary from other sources than KTH, to carry out postgraduate studies, or students that otherwise can finance their postgraduate studies in a reasonable way.
Admission takes place continuously, throughout the year. Doctoral students admitted under an academic year are regarded as belonging to the same school year.

Within the ITM school, most of the supervisors for the program are found at the Department of Energy engineering. The number of qualified principal supervisors is estimated to be about ten.

**Funding**

The research at the Department of Energy engineering is traditionally mainly financed by Energimyndigheten, Vinnova, Formas, SIDA (the Swedish International Development Authority), through EU-projects, and through cooperation with industry. This funding is expected to apply also for doctoral students within the doctoral programme. Doctoral students can also be financed through scholarships/salary within Erasmus Mundus, EIT or other bilateral or multilateral agreements.

**Courses**

The courses within the doctoral programme are all offered within a third-cycle subject and are therefore presented in the study plan for the subject.

**Quality enhancement activities**

The program is led by a programme co-ordinator together with a programme council consisting of four representatives appointed through election within the supervisor assembly and two doctoral student representatives. The programme council is responsible for the quality and development of the programme. The programme council convenes two times per year. On these occasions, completed third-cycle courses and the doctoral students' progress are discussed.

All supervisors connected to the program are included in the supervisor assembly of the programme. The supervisor assembly constitutes the academic arena for collegiate discussions of supervision issues, research quality, final reviews, doctoral students' progress, follow up of study plans, third-cycle courses, experimental resources etc. The supervisor assembly meets at least two times a year, normally shortly before the meetings of the programme council so that current issues can be quickly brought forward to the council.

The doctoral students of the program are expected normally to take a licentiate degree, even if a doctoral degree is the final goal. In the case the principal supervisor and the doctoral student agree that a licentiate degree should not be taken, an intermediate seminar should be held when the doctoral student has achieved approximately the half of the requirements for a doctoral degree. To this seminar, an external expert should be invited as reviewer. At the seminar, both achieved results, and planned specialisation for the continued work. The reviewer should give a statement about the completed work and a recommendation for the planned continuation.

Each doctoral student should have at least one assistant supervisor. The assistant supervisor should have a doctoral degree, or equivalent skills. The division of responsibility between the principal supervisor and the assistant supervisor should be established in the study plan.

No later than three months before the public defence of doctoral thesis an open final review is held, where the doctoral student presents his/her work. At the seminar, an internally appointed external expert participates as a reviewer. After presentation and interrogation, the supervisor assembly and the reviewer meet. Besides the supervisor and the assistant supervisor, at least two other individuals from the supervisor assembly should be present. At the meeting, the contents and quality of the thesis are discussed. The principal supervisor explains that the thesis is ready to be defended. The external expert/reviewer gives, as internal quality reviewer, his approval, possibly with certain reservation concerning changes in the thesis. The supervisor also presents proposals for opponent/reviewer and examination committee. If the supervisor assembly finds that the thesis satisfies the quality standards, the supervisor is asked to bring the process further to the public defence of the doctoral thesis.

Theses can be written as a monograph or a compilation thesis. Unless special reasons exist, the thesis should be written in English.
A thesis should contain new theoretical and/or empirical research results within the field that the doctoral student has chosen to develop, via theoretical and empirical research work. The thesis should contain an overview of relevant previous research and position the students contribution in relation to previous research.

Whether the thesis is presented as a monograph or as a compilation thesis of scientific articles, it should be of such quality that the doctoral student's contribution is assessed to correspond to at least four articles published in internationally recognised scientific magazines with referent review.

These rules are subordinate to KTH's joint regulatory frameworks and quality assurance standards for public defence of doctoral thesis.

**National and international network**

Once per academic year, all doctoral students and supervisors within the programme assemble at a two-day program workshop. The aim of this is:

- To broaden the knowledge of ongoing research project within the program, among doctoral students and supervisors.
- To strengthen the bands between students admitted during different school years and between specialisations within the programme.
- To give interesting lectures of general interest for doctoral students and supervisors.
- To give general information about current issues within KTH and the ITM school.
- To give a possibility to discuss the programme and its implementation in order to strengthen and develop the quality of the programme.

As already have been said Energy engineering is a generic and interdisciplinary subject. It is thereby important to maintain regular and good contacts with other programs within KTH with adjacent specialisations. These programmes will be identified and invited to participate in a cross-programme network. The network should be arranged as a part of the Energy platform at KTH. The aim of the network is:

- To inform about third-cycle courses to facilitate recruitment of students between the programmes
- To create joint third-cycle courses or to share teacher resources for third-cycle courses within the programmes
- To exchange information about current research and thereby to encourage cross-border joint projects.

It is expected that this network will lead to cross-programme cooperations within more narrow subareas of energy technology.

The department of Energy engineering has the most well developed cooperation at KTH within first and second cycle education with other universities through three Erasmus Mundus programmes, a Nordic Master, distance education in collaboration with a large number of universities, student and teacher exchange.

The doctoral student cooperation within Erasmus Mundus and within EIT is under construction. At the department, there are also a number of adjunct and associated professors and other supervisors through which good contacts with the industry and other universities are maintained.

It is an aim that each doctoral student within the program should spend one semester at another university.

The above is enumerated and defined in appendix 3.

**Further instructions for registration**

**Appendixes**

Appendix 1: Study plan for third-cycle subject Energy Technology (ENERGIT).

Appendix 2: List containing names and subject areas of supervisors within the programme

Appendix 3: Presentation of the programme’s national and international network
Doctoral programme — Energy Technology and Systems

Appendix 1: Study plan for third-cycle subject Energy Technology (ENERGIT).

The subject plan was approved by Fakultetsnämnden (Faculty Board) June 1, 2010. Valid from Autumn 10.

Subject title
Energy Technology (Energiteknik)

Subject description and programme outcomes

Scientific field
The energy supply has become a key issue for human existence: Under the latest 150 the years our energy supply has gone from being based on muscle force from people and draught animals to being based on stored, finite energy resources in the form of fossil fuels and uranium. This has facilitated a remarkable improvement of the living conditions for large parts of the population of the earth, but has at the same time led to problems: The us of fossil fuels has, together with other human activities, led to increased carbon dioxide concentration in the atmosphere and thereby to a warmer climate. The finite resources are also starting to run out, which inevitably will to lead higher prices on energy in all forms and thereby requirements on more efficient transformation and use of the energy. The research within the department of Energy technology aims at contributing to solve the abovementioned problems. The research can encompass a broad field, including both general system studies and development of components for parts of the energy system and studies of phenomena and processes that act at energy conversions.

The third-cycle subject area includes:
- technical as well as socio-economic studies of energy systems on both general (international, national) and local level
- methods, systems and components for energy conversions, both from primary energy to work, electricity and heat, and from work, electricity, heat to services that are requested in the society
- physical phenomena that act in connection with energy conversion processes
- methods for limitation of the impact on the environment caused by energy conversion processes, including use of flowing energy sources and methods for more efficient use of energy

The aim for education for third-cycle studies at KTH is described in general terms in the decision of the president of KTH no UF 0044-09*. In particular, the aim for the doctoral programme in Energy and environmental systems is to educate researchers with internationally recognised specialist competence within their profile areas, with an independent and systematic working method, being well aware of the importance of their own field for the energy system as a whole.

* https://intra.kth.se/regelverk/utbildning-forskning/forskarutbildning/handledning-studieuppfoljning/individuell-studieplan-1.27239

Description of possible specialisation
The subject has no specialisations.
Specification of how the programme outcomes are to be achieved

The basic third-cycle subject area is Energy technology No prescribed specialisations are defined, but to the extent that KTHs regulatory framework allows, the specialisation of the thesis will be stated in the degree certificate.

The research is carried out within both individual fields and in collaboration across subject borders. Cooperation with researchers within other disciplines is encouraged.

The study plan for a third-cycle subject contains common courses for all doctoral students, while groups of students with similar specialisation are expected follow specific advanced courses.

The aim for the postgraduate education in Energy technology is that the doctoral students should become independent researchers with expertise in the research area within their field, making it possible to be admitted to post-doc employments at well renowned universities anywhere in the world, with this postgraduate education.

The doctoral student should after completed studies be able to:

- formulate concrete research issues within the energy field.
- use scientific methods and provide new knowledge through own scientific studies
- critically analyse and evaluate applied methods and results from own and others'scientific studies
- present and discuss research results in the science community.
- identify the need for new knowledge
- initiate and lead research.
- present research in an pedagogical way outside the science community and in educational situations
- assess ethical aspects of his/her own research and act from these.

Current research

Ongoing research deals with:
- increased efficiency in different energy conversion systems,
- primary energy flexible polygeneration processes of different sizes,
- heat-driven energy conversion and distillation plants,
- gasification, combustion and conversion of biofuels,
- aerodynamics and aeroelasticity in turbomachines,
- development of fuel cells and its connection to energy conversion systems,
- improvement of energy efficiency in buildings,
- design of the heat pump systems,
- the city as an energy system,
- calculations of heating and cooling needs in buildings,
- efficiency improvement of the heat transfer in heat exchangers,
- energy storage,
- alternative refrigerants,
- alternative cooling processes etc.,
- cooling of electronics,
- development of bioenergy systems and integration of such in the energy system as a whole,
- electrification in rural areas with centralised and decentralised electricity production,
- energy and climate policies to support sustainable development both in industrialised countries and developing countries,
- infrastructure and market development for renewable energy options,
- low energy houses, net-zero energy houses etc.,
- modelling energy need and indoor climate in buildings with BIM tools,
- energy efficient shops, hotels and restaurants,
- user behaviour and visualisation of energy use in buildings.
Programme structure

The doctoral students of the programme follow an established individual study plan, which includes joint courses at KTH, school and department level. These courses are intended to give a common basis for knowledge building within each doctoral student's speciality. It however is important to establish that the education of the programme is a specialist education where the predominant part of the credits are specific for a certain specialisation within the programme.

The Ph.D. education is carried out under the guidance of a principal supervisor together with one or several assistant supervisors. The principal supervisor should be a professor, a visiting professor or an adjunct professor, that is employed at KTH. If an adjunct professor is the principal supervisor, he/she should also be docent at KTH. Other individuals that are docents and have permanent posts at KTH can also be appointed principal supervisor. Assistant supervisors are appointed partly to meet requirements of supplementary specialist competence that can be required for the research specialisation, partly to obtain a supplementary discussion partner for the doctoral student. The assistant supervisor should have a Ph.D. degree, or have equivalent skills. The division of responsibility between principal supervisor and assistant supervisor should be established in the study plan.

Compulsory and recommended courses

Compulsory courses: Introductory course for new doctoral students 1 credit The epistemology of engineering, science and Innovation (course at ITM) 2 credits KTH's pedagogical course for doctoral students (compulsory for doctoral students who should participate in the teaching) 3 credits Research seminars within Energy technology 5A5002 3 credits Writing Scientific Papers F9E5100 3 credits Research seminars in Energy technology F1N5111 (or the corresponding) 4.5 credits Energy systems course, e.g. national course of Swedish Energy Agency 7.5 credits

Exception from obligations may be done under certain circumstances. Transfer of courses from the first and second cycle programmes may take place according to KTH's regulatory framework.

Recommended courses Literature study course 4A5004 15 credits Writing popular science 4A5007 3 credits

It is a ambition that each doctoral student within the program should spend one semester at another university.

Thesis

Licentiate thesis

A licentiate thesis should contain an application of existing scientific knowledge within a new field that the student has developed via theoretical or empirical research. It should also contain an overview of previous research within the chosen subject area and position the doctoral student's contribution in relation to previous research.

Whether the licentiate thesis is presented as a monograph or as a compilation thesis of scientific articles, it should be of such quality that it is assessed to correspond to at least two articles published in internationally recognised scientific magazines with referent review. For a compilation thesis, the doctoral student should be sole author of at least one article.

After approval from the principal supervisor, the licentiate thesis is presented at a public seminar with an external reviewer/opponent.

Doctoral thesis

Theses can be written as a monograph or a compilation thesis. Unless special reasons exist, the thesis should be written in English.

A thesis should contain new theoretical and/or empirical research results within the field that the doctoral student has chosen to develop, via theoretical and empirical research. The thesis should contain an overview of relevant previous research and position the doctoral student's contribution in relation to previous research.
Whether the thesis is presented as a monograph or as a compilation thesis of scientific articles, it should be of such quality that the doctoral student's contribution is assessed to correspond to at least four articles published in internationally recognised scientific magazines with referent review.

**Entry requirements and selection**

**General and special admission requirements and prior knowledge**

General admission requirements according to Higher Education Ordinance (HF), chapter 7, section 39 has those that have
1. been awarded a second-cycle qualification,
2. satisfied the requirements for courses comprising at least 240 credits of which at least 60 credits were awarded in the second-cycle, or
3. acquired substantially equivalent knowledge in some other way in Sweden or abroad.

Doctoral students should be able to read and write scientific English and be able to speak English fluently.

No specific entry requirements are applied. At the selection, the applicants are assessed from the requirements in the specific project.

**Selection rules and procedures**

The program is primary directed towards recruiting Swedish and foreign Master of Engineering/M. Sc. graduates with energy engineering specialisation (or the equivalent). Due to the multi-disciplinary nature of the subject, students with other technical or non-technical background could be considered in certain projects. The selection takes place based on the applicant’s academic and personal qualifications and the student’s ability to benefit from the postgraduate education. The selection is governed by HF, chapter 7, section 41.

Admission takes place continuously throughout the year. Doctoral students admitted anytime during an academic year are regarded as belonging to the same school year.

**The programme’s degrees and examinations**

**Degree of Licentiate and Degree of Doctor (PhD)**

- For Degree of Licentiate, 120 credits are required, of which the course module should comprise at least 30 credits.
- For Degree of Doctor, 240 credits are required, of which the course module should comprise at least 60 credits.

The doctoral students of the program are normally expected to take a licentiate degree, even if a doctoral degree is the final goal. In the case the principal supervisor and the doctoral student agree that Degree of Licentiate should not be taken, an intermediate seminar should be held when the doctoral student has reached half of the requirements for a Degree of Doctor. To this seminar, an external external expert should be invited as reviewer. At the seminar should both achieved results, and planned specialisation for the continued work be presented. The reviewer should give a statement about the completed work and a recommendation about the planned continuation.

No later than three months before the public defence of doctoral thesis an open final review is held, where the doctoral student presents his/her work. At the seminar, an internally appointed external expert participates as a reviewer. After presentation and interrogation the supervisor assembly meet. At the meeting, the contents and quality of the thesis are discussed. The principal supervisor explains that the thesis is ready to be defended. The external expert the reviewer give his/her approva as an internal quality auditor, possibly with certain reservations concerning changes in the thesis. The supervisor also presents proposals for opponent/reviewer and examination committee. If the supervisor assembly finds that the thesis satisfies the quality standards, the supervisor is asked to bring the process further to the public defence of the doctoral thesis.

These rules are subordinate to KTH’s joint regulatory frameworks.
The programme’s examinations

No general tests apart from examination of courses.
Doctoral programme — Energy Technology and Systems

Appendix 2: List containing names and subject areas of supervisors within the programme

The programme description was approved by Fakultetsnämnden (Faculty Board) June 1, 2010. Valid from Autumn 10.
Doctoral programme — Energy Technology and Systems

Appendix 3: Presentation of the programme’s national and international network

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