

Sustainable systems/Hållbara system

Please note that this is a translation of a legal document and is not in itself legally valid. In the event of any differences, the Swedish document takes precedence.

The doctoral subject Sustainable Systems comprises the following subject areas:

- Energy Systems / Energisystem / SCB code: 20702 /
- Environmental Management and Engineering / Miljömanagement och miljöteknik / SCB code: 20707 /

Subject description

The doctoral subject *Sustainable Systems* is characterized by an interaction between the subject areas Energy Systems and Environmental Management and Engineering. With a system perspective on sustainable development, issues are analyzed based on resource, energy, and environmental dimensions. The doctoral education should develop knowledge and skills in how to scientifically formulate and solve problems and report results. The goal is to train licentiates and doctors at an internationally competitive level with good knowledge in a broad application area, trained in scientific research methodology and with a high specialist competence in the own research work.

Sustainable systems has its starting point in the engineering science perspective and include studies in areas such as increased resource efficiency, transition to renewable energy sources, efficiency of new and existing energy systems, strategic environmental work such as organizational development, innovation and entrepreneurship, development, and dissemination of new environmental technology solutions as well as tools and methods for energy and environmental system analysis.

Doctoral education in *Sustainable Systems* is characterized by a broad system view where processes around resources, energy and environmental issues are analyzed long-term and with a critical approach. The doctoral education combines empirical studies with system-analytical, quantitative, and qualitative methods.

Eligibility and selection

The basic eligibility and general principles for selection are stated in the faculty's *Study Handbook for Education at the Research Level*.

Specific eligibility

Eligible for admission to education at the research level in *Sustainable Systems* is the one who has completed course requirements of at least 60 credits at the advanced level related to the subject. These 60 credits must include an independent work (degree project) with a scope of at least 30 credits in an area relevant to the doctoral subject.

Degree

Education at the research level in *Sustainable Systems* leads to a doctoral degree or licentiate degree. The latter can also constitute a stage in the doctoral education. The licentiate degree comprises 120 higher education credits, of which the dissertation work corresponds to studies of 60-80 higher education credits and courses of 40-60 higher education credits, of which at least two thirds of the course requirements for the degree must be at the research level. The doctoral degree comprises 240 higher education credits, of which the dissertation work corresponds to studies of 150-180 higher education credits and courses of 60-90 higher education credits, of which at least two thirds of the course requirements for the degree must be at the research level. The distribution between course credits and dissertation credits is regulated in the first established individual study plan.

Objectives and implementation of the education

Common goals and purposes of the education are stated in the introduction of the faculty's *Study Handbook for Education at the Research Level* as well as in the Higher Education Ordinance's degree (reproduced in appendix to the Study Handbook).

Education at the research level in Sustainable Systems aims to enable the student to achieve in-depth subject knowledge, skills in research methodology and academic publishing as well as research experience, to thereby be able to contribute to the existing knowledge within the subject area and become well prepared for continued independent scientific activity or other qualified professional activity within the subject area.

More specifically, after completing the education, the student should have developed:

- an in-depth understanding of previous research within the subject area as well as insight into contexts and relationships essential for the subject,
- the ability to identify, formulate, structure, and analyse relevant problems and issues within the subject area,
- in-depth knowledge in scientific methodology and ability to choose and apply methods for study design and for collection and analysis of empirical data,
- the ability to draw conclusions and formulate recommendations for relevant stakeholders based on their own empirical research,
- the ability to present research results in writing and orally for different target groups,
- the ability to critically review their own and others' research contributions.

The education at the research level in *Sustainable Systems* provides the PhD student with the conditions to fulfil all the degree goals. The education consists of research and dissertation work, courses, participation in seminars, participation in national and international conferences and collaboration with external organizations (such as industry and / or organizations within public administration).

The education gives the PhD student broad knowledge and understanding of *Sustainable Systems* by having the PhD student follow the seminar series for *Sustainable Systems* that is given within the doctoral subject, participate in the broadening courses that are common for *Sustainable Systems* and / or the Department of Management and Engineering, and participate in the teaching of undergraduate courses in *Sustainable Systems*. For PhD students who teach, a basic course in university pedagogy is also included as a compulsory course.

The PhD student acquires comprehensive knowledge and understanding of *Sustainable Systems* and especially within their research focus by actively participating in in-depth courses that are determined based on direction, dissertation focus and what is evident from the individual study plan, performing independent work within one or more research projects, participating in discussions at seminars and conferences, and presenting research ideas / results. The PhD student develops familiarity with scientific methodology through their

own research, and by undergoing a compulsory course in research methodology and institution-wide doctoral education activities.

PhD students in *Sustainable Systems* acquire skills and abilities by:

- independently plan and carry out their research work,
- conduct research work in parallel with course-based studies,
- during the study period take part in the scientific activity that is conducted at the department and, by attending seminars, workshops, and guest lectures etc.,
- during the study period conduct a few seminars during (e.g., half-time, and final seminars) where the results achieved so far and plans for the continued dissertation work are presented,
- participate in international conferences and present their own research to practice their ability to present in front of colleagues from their own and adjacent research fields and to critically review both their own research and the other participants' research work.

In sustainable systems, the PhD students' abilities in evaluation and approaches are developed partly through participation in research ethics courses and partly by participating in the seminar series within the subject *Sustainable Systems*, as well as participating in institution-wide doctoral education activities. PhD students in *Sustainable Systems* show intellectual independence by writing and defending a doctoral dissertation. The education gives the PhD student a in-depth insight into the possibilities of science to contribute to a sustainable social development. This is achieved through faculty-wide course requirements, and through participation in continuous discussions at, for example, research seminars and through a reflection on sustainability aspects of their own research work.

Dissertation

The topic of the dissertation is chosen in consultation with the supervisor. For the licentiate degree, the PhD student must write a scientific dissertation that must be defended at a public seminar. For the doctoral degree, the student must write a scientific dissertation, which is defended at a public defence. The dissertation should have been fully or partially subjected to international assessment.

PhD students in *Sustainable Systems* show intellectual independence by gradually taking more initiative and responsibility for the design of the research and for writing the articles included in the dissertation during the education.

In the dissertation work, the PhD student must show their ability to contribute significantly to the development of knowledge within their own research field through their own research and show the ability to identify the need for further knowledge. The PhD student must show intellectual independence and scientific honesty, an ability to make research ethical assessments and a in-depth insight into the possibilities and limitations of science, its role in society and people's responsibility for how it is used.

The dissertation can be either a monograph or a compilation dissertation. In the latter case, the dissertation consists of a scientific introductory text and a number of attached scientific articles. The introduction text sets the dissertation in its scientific and social context, shows the PhD student's familiarity with theory and scientific method, shows the attached articles' cumulative contribution to the field of knowledge, and provides an additional contribution in itself, e.g., an integration of the articles into a whole. The number of articles may vary depending on the PhD student's own contribution in each work, the number of co-authors, the scope and scientific contribution of the articles. Normally, a licentiate degree consists of 2-3 research articles that are at the level for international publication. A compilation dissertation for a doctoral degree normally contains at least 3 articles that have been accepted for publication in international scientific journals and additionally normally at least 2 articles that are at the level for international publication. In a compilation dissertation, it must be clearly stated that the PhD student has significantly contributed to the articles and what other co-authors have contributed with.

Individual study plan

An individual study plan must be established for each PhD student. The detailed planning of courses and other elements is done in consultation with the supervisors and documented in the individual study plan (see *Study Handbook for Education at the Research Level*, section 5.3). The study plan is established no later than one month after admission and revised at least once a year.

Supervision

General provisions for supervision are found in the *Study Handbook for Education at the Research Level*, Chapter 4, and in the Policy for Supervision within Doctoral Education at LiTH.

Courses

Faculty-wide course requirements

Theory of science, methodology, ethics, gender equality and sustainability

All PhD students must have completed compulsory courses in theory of science, methodology, ethics, gender equality and sustainability decided by the faculty, or be assessed to have equivalent competence.

Pedagogical education

All PhD students who teach must undergo a basic pedagogical course. At least 3 higher education credits from this course must be included in the education at the research level and any remaining credits must be counted as institutional service (see *Study Handbook for Education at the Research Level*, section 5.5).

Subject-specific courses

For PhD students in the main subject Sustainable Systems, the following courses are compulsory:

- Systems and Management I, 4 higher education credits
- Systems and Management II, 4 higher education credits
- Seminar series *Sustainable Systems*, 4 higher education credits

The activities covered by the seminar series include an initial seminar where the PhD student presents early research ideas, a half-time seminar or licentiate seminar and a final seminar.

Crediting

Crediting is done according to the *Study Handbook for Education at the Research Level*, section 5.6.

Subject areas

The following descriptions are given of the different subject areas within *Sustainable Systems*, as well as the specific course requirements that apply to each area.

Energy system

The subject area Energy system is characterized by system thinking and holistic perspective. The research covers areas from energy conversion to distribution and use of energy with the aim of showing conscious and active actions that accelerate and lead to the development of sustainable energy systems, both in

planning and construction of a new energy system and in renovation and retrofitting of an existing energy system. Examples of actions that are studied are energy efficiency in buildings and industries, transition to renewable energy sources and increased resource efficiency. The subject area Energy system is characterized by a general system perspective. In the research, analytical, mathematical, and numerical methods are combined with detailed measurements and qualitative methods.

Subject-specific course requirements

The subject area Energy system has the following mandatory courses to provide a broad knowledge and understanding in the direction of the subject:

- Energy System Analytical Tools I, 4 higher education credits
- Energy System Analytical Tools II, 4 higher education credits

Environmental management and engineering

The subject area Environmental management and engineering focuses on how environmental problems and perspectives lead to changes in products, services, technical systems and organizations and how these changes in turn affect the environment. With environmental management is meant strategic environmental work in organizations such as organizational development, innovation, and entrepreneurship in the environmental field. Environmental engineering covers development and dissemination of new environmental technological solutions as well as design and use of various tools and methods for environmental system analysis. Research can be carried out within or a combination of above-mentioned perspectives. Research is carried out mainly as empirical studies of individual organizations or networks of organizations, products, services, product-service systems, or technical systems. In all research a broad systems approach is applied, and a multi-disciplinary approach is used.

Subject-specific course requirements

The subject area Environmental management and engineering has three mandatory courses to provide a broad knowledge and understanding in the subject:

- Industrial symbiosis, 4 higher education credits
- Environmental systems analysis, 4 higher education credits
- Corporate environmental management, 4 higher education credits

Transition provisions

Changes in the general study plan do not apply to those PhD students who have already been admitted to the subject. A transition to the new study plan can however occur if both main supervisor and the PhD student agree. This should be documented in the individual study plan.

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