Programme syllabus

Master's Programme, Energy Innovation, 120 credits
Masterprogram, innovativ energiteknik
120.0 credits

Valid for students admitted to the education from autumn 17 (HT - Autumn term; VT - Spring term).

This is a translation of the Swedish, legally binding, programme syllabus.

Programme objectives

The master's programme in Energy Innovation (InnoEnergy) is an umbrella programme which is directed towards a completely new type of education in the energy field, mobilising the innovative and entrepreneurial spirit of the students. At the same time, the full energy knowledge students receive in "classical" two year energy master programmes is kept. This will give the graduates a very deep understanding of the world's energy challenges paired with a significant insight into how energy businesses are created and into the industrial perspective of the energy side in different fields.

The KIC InnoEnergy MSc programmes are specially designed to accommodate the EIT/InnoEnergy label criteria.

Objectives of the study tracks:

• Smart Cities (SMCS)

This specialization deals with the concepts of “Smart Cities” based on scientific literature and reports from case studies.

Studies to investigate, analyze and explore “Smart City“ concepts and solutions in relation to the energy and climate mitigation challenges for important urban development sectors, such as transportation, buildings, consumption, lifestyle, energy production, waste management, water management, etc.

Team-based projects, related to energy and climate mitigation on an urban level together with a relevant stakeholder such as a waste company, the municipality, or a local energy or water utility.

• Smart Electrical Network and Systems (SENS)

SENS focus on how new technological developments electric power in combination with modern information technologies can transform the existing electric power grid infrastructure towards a more 'smart' power network.

After completion of SENS the students should be able to identify, explain, analyze and solve classical problems within the field of electric power engineering, but also analyze new concepts and innovations and their possibilities and limitations - all from idea to final product.

Be able to use models for: analysis of power flows, dynamic behaviour, stability conditions, regulations, electricity market, etc for the electric power system.

Know and apply principles for design, control and monitoring of the electric power grid and its components.

Be able to apply fundamental electromagnetic and physical principles in order to develop models and design critera for electric power appartuses and components including technolgies that makes them 'smarter'.

Anlayze and syntesize different methods for electric energy conversion based on rotating machines and power electronics.

• Renewable Energy (RENE)

This specialization focuses on the renewable technologies, such as wind energy, concentrated solar thermal power, solar photovoltaic energy, ocean energy, hydro power and geothermal energy.

• Nuclear Energy (NUEY)

This specialization deals nuclear energy engineering. The track is run in close collaboration with industrial partners and provides the latest trends in innovation in nuclear energy.

The track aims at giving the students not only technical knowledge, but also economical, organisational and managerial knowledge. During the second year of studies students will be able to choose following tracks:

• Materials for Nuclear Energy,

• Decommissioning and nuclear waste

• Nuclear Fuel cycle

• Nuclear plant design

Knowledge and understanding

For a master’s degree in Energy Innovation the student shall:

• Have knowledge and understanding of cutting-edge research and development and trends within industry

• Have knowledge and understanding of processes, methods, and tools used for development of specific technologies;

• Have knowledge of how to implement a business development process from idea to product.

Skills and abilities

For a master’s degree in Energy Innovation the student shall:

• be able to apply his/her knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to the field of study.

• have the ability to think beyond boundaries and systematically explore and generate new ideas. (creative skills)

• have the ability to use knowledge, ideas or technologies to create new or significantly improved products, services, processes or policies or new business models. (innovation skills)

• have the ability to transform innovations into feasible business solutions. (entrepreneurial skills)

• have the ability to transform practical experiences into research problems and challenges. (intellectual transforming skills), and have the capability to work in cross-disciplinary teams in the thematic field of the KIC. (research skills)

• demonstrate leadership and decision-making, based on a holistic understanding of the contributions of higher education, research and business to value creation, in limited sized teams and contexts. (leadership skills)

• have the ability to communicate his/her conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously, both orally and in writing. (communication skills)

Ability to make judgements and adopt a standpoint

For a master’s degree in Energy Innovation the student shall:

• have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information;

• demonstrate an appreciation of ethical, scientific and sustainability challenges

Extent and content of the programme

The programme lasts for two academic years (120 ECTS) on the advanced level (second cycle). The language of instruction throughout the programme is English.

Tracks:

• Smart Cities (SMCS)

• Smart Electrical Networks and Systems (SENS)

• Renewable Energy (RENE)

• Nuclear Energy (NUEY)

Eligibility and selection

Basic eligibility to be accepted to the master’s programme requires that the applicant has a degree on the first level consisting of at least 180 higher education credits or a corresponding foreign degree.

Students in their final year of undergraduate education may also apply and receive a conditional offer if they are likely to complete their Bachelor’s degree at the latest at the date of programme registration. Information about the conditional acceptance shall be conveyed in the admission letter. A written statement from the Degree Administrations Office (or equivalent department), giving the expected completion date should be included in the application documents.

Applicants following longer technical programmes and who have completed courses equivalent to an amount of 180 ECTS, will be considered on a case-by-case basis.

Language requirements

Applicants must be able to show good knowledge of written and spoken English. If the requirements for English proficiency are higher at one of the partner universities than at KTH, this can influence KTH decision on admission. The requirements may however not be lower than those listed below.

Applicants must provide proof of their English language proficiency, which is most commonly established through an internationally recognized test. The following test results are accepted by KTH.

• TOEFL internet based test, total of 92, 22 writing section

• IELTS score of at least 6.5, no band lower than 6 (only academic training accepted)

• University of Cambridge ESOL Examinations (minimum grade C):

• Certificate in Advanced English

• Certificate of Proficiency

Some student groups may be exempted from taking an English proficiency test. For more information see the programme website.

Specific eligibility

Smart Cities (SMCS)

Bachelor's degree in electrical engineering or mechanical engineering. Degrees in Sciences, Economics or Management are eligible, but may be subject to preparatory courses.

Smart Electrical Networks and Systems (SENS)

• electrical engineering (including three phase electrical circuits or machines) equivalent to 60 higher education credits

• mathematics (calculus, numerical methods, algebra, probability theory) equivalent to at least 30 higher education credits.

Renewable Energy (RENE)

Bachelor of Science in Mechanical or Chemical Engineering and related disciplines

Coursework in engineering thermodynamics, heat transfer, and fluid mechanics, with 6 hp as the approximate minimum threshold.

Nuclear Energy (NUEY)

Bachelor degree (180 ECTS) in Engineering Physics, Mechanical Engineering, Materials Engineering, Chemical Engineering, or Power Engineering.

Selection process

The selection process is handled by the coordinating institution of each track. However it should be in accordance with KTH's admission regulations.

Implementation of the education

Structure of the education

The study year for KTH's undergraduate education is divided into two semesters, each with two study periods (four study periods in total over the year). Each study period is followed by an exam period. For detailed information about the academic year please see the KTH student web.

Within the European Institute of Innovation and Technology (EIT) KTH participates in the Knowledge and Innovation Community (KIC) InnoEnergy. The Energy Innovation programme is an umbrella structure for the different master’s programmes offered within EIT KIC InnoEnergy. InnoEnergy aims to provide education programmes at master level with significant elements of innovation and entrepreneurship. All these programmes take place in cooperation with several other universities as well as partners in industry which offers internships to the students. These programmes will be designed as tracks within the Energy Innovation master's programme.

The Energy Innovation programme offers a heavy technical component in the traditional engineering sense combined with significant business and entrepreneurship activities throughout the whole curriculum to educate fresh engineers with either a broad overall view of the energy area, a specialized education in one of the thematic areas of the CCs, or an overview of the “well-to wheel” polygeneration perspective.

Courses

The programme is course-based. Lists of courses are included in appendix 1.

Grading system

Courses in the first and the second cycle are graded on a scale from A to F. A-E are passing grades, A is the highest grade. The grades pass (P) and fail (F) are used for courses under certain circumstances.

The grades pass (P) and fail (F) are also used for the degree project.

Since the grading systems differ between different countries, the grades from studies abroad will not be transferred to the KTH grading system.

Conditions for participation in the programme

Registration for the term

All students accepted to a programme must register for each term they intend to actively pursue studies. For newly admitted students this is done in connection with the compulsory registration meeting at beginning of term. For all following terms of the program, the student enters the registration for the term via their Personal Menu at www.kth.se. The registration is possible during a limited time period. This registration is necessary for reporting of results and required so that student's stipend (studiemedel) can be disbursed by CSN.

Course Selection

The selection of courses for the coming term must be done by the student via the www.antagning.se with the students KTH-account:

- May 1-15th for the fall term
- November 1-15th for the spring term

Course registration

Each student must before every study period register for all courses they are admitted to. The course registration is done via the Personal Menu at www.kth.se. If the student decides not to take a course, then the student should notify the course administrator.

Conditions for being promoted to the next level

For promotion to study year two at a partner university, the student should have passed all 60 credits from the first year, but a minimum of 45 higher education credits are obligatory.

Recognition of previous academic studies

According to the Swedish Higher Education Ordinance, a student who has gone through certain first-cycle study courses and study programmes with a passing result has the right to have such credit recognised for a corresponding course of education at another institution of higher education. The Program Director will make the decisions concerning recognition of entire courses. Awards of credits for parts of courses may be decided upon by an examiner.

For further information on recognition of previous academic studies, see the KTH:s regelverk.

Studies abroad

The Energy Innovation program strongly emphasizes mobility between the universities. The education takes place at two different European universities depending on track. Students offered 'double degrees' from the University after completion of studies.

For the different track, the following mobility options apply:

Smart Cities (SMCS)

First year: · KULeuven, KTH

Second year: · KULeuven, KTH, UPC, Grenoble INP

Smart Electrical Networks and Systems (SENS)

First year: KTH

Second year: INP Grenoble, KU Leuven, TU/e Eindhoven and UPC Barcelona

Renewable Energy (RENE)

First year: · ParisTech, IST, UPC, KTH

Second year: · ParisTech, IST, UPC, KTH

Nuclear Energy (NUEY)

First year: · KTH, UPC

Second year: · ParisTech, Grenoble INP

Degree project

General rules and policies regarding the diploma work and its grading can be found in the KTH regulations.
The diploma work amounts to 30 credits, which should equal 20 weeks of full time studies. A student may apply for starting a thesis project given that most of the course work has been accomplished, corresponding to 60 credits out of which at least 30 credits at the advanced level within the major subject of the program.

The thesis should be implemented within the main field of study and it is encouraged to link the thesis to industry.

The degree project is graded according to the P-F scale, using the three bases for assessment common to all grading at KTH: the engineering and scientific content, the process, and the presentation.

Degree

KTH’s procedure for awarding degrees is described in the KTH regulations. The Master’s degree is awarded after fulfilling all requirements defined by the program. This includes a total of 120 credits out of which 90 credits are at the advanced level and at least 60 credits (including 30 credits for the thesis work) corresponds to advanced level courses within the major subject of the program.

The name of the degree is “Teknologie Mastersexamen”, which in English translates to “Degree of Masters of Science (two years)”. The program name, Energy Innovation, is indicated on the diploma.

When the student has successfully completed the degree requirements of the degree-issuing institutions, the student obtains a nationally recognized degree from the institutions at which he/she successfully completed a part of the programme, thereby obtaining double or multiple degrees.

Students who completed part of the program at KTH and fulfill the degree requirements for KTH receive a degree from KTH.

The student applies for their degree via the ”Personal Menu” at www.kth.se.

KTH's local degree ordinance is available in their entirety in the KTH regulatory framework that can be found on the intranet. The main subject for the degree will be stated in the degree certificate .

Appendix 1 - Course list
Appendix 2 - Programme syllabus descriptions

Appendix 1: Course list

Master's Programme, Energy Innovation, 120 credits (TIETM), Programme syllabus for studies starting in autumn 2017

Track, Nuclear Energy (NUEY)

Year 1

Mandatory courses (38.0 Credits)

Course code	Course name	Credits	Edu. level
MJ2405	Sustainable Power Generation	9.0 hp	Second cycle
SH2600	Nuclear Reactor Physics, Major Course	9.0 hp	Second cycle
SH2603	Radiation, Protection, Dosimetry and Detectors	6.0 hp	Second cycle
SH2702	Nuclear Reactor Technology	8.0 hp	Second cycle
SH2773	Nuclear Power Safety	6.0 hp	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
KD2290	Reactor Chemistry	6.0 hp	Second cycle
MJ2411	Renewable Energy Technology	6.0 hp	Second cycle
SH2302	Nuclear Physics	8.0 hp	Second cycle
SH2604	Generation IV Reactors	6.0 hp	Second cycle
SH2605	Radiation Damage in Materials	6.0 hp	Second cycle
SH2610	Leadership for Safe Nuclear Power Industry	6.0 hp	Second cycle
SH262V	Elements of the Back-end of the Nuclear Fuel Cycle: Geological Storage in Precambrian Bedrock	7.5 hp	Second cycle
SH2701	Thermal-Hydraulics in Nuclear Energy Engineering	6.0 hp	Second cycle
SH2703	Nuclear Reactor Dynamics and Stability	6.0 hp	Second cycle
SH2704	Monte Carlo Methods and Simulations in Nuclear Technology	6.0 hp	Second cycle
SH2705	Compact Reactor Simulator- Exercises in Reactor Kinetics and Dynamics	6.0 hp	Second cycle
SH2772	Chemistry and Physics of Nuclear Fuels	8.0 hp	Second cycle

SH2774	Numerical Methods in Nuclear Engineering	6.0 hp	Second cycle

Supplementary information

Course list: Information is based upon the curriculum for academic year 2016/2017. Changes may occur.

At least 4 of the recommended elective courses should be selected.

Track, Renewable Energy (RENE)

Year 1

Mandatory courses (48.0 Credits)

Course code	Course name	Credits	Edu. level
MJ1402	Introduction to Energy Technology	3.0 hp	First cycle
MJ1432	Practical Energy Related Project	9.0 hp	First cycle
MJ2405	Sustainable Power Generation	9.0 hp	Second cycle
MJ2407	Sustainable Energy Utilisation	9.0 hp	Second cycle
MJ2411	Renewable Energy Technology	6.0 hp	Second cycle
MJ2413	Energy and Environment	6.0 hp	Second cycle
MJ2424	Computational Methods in Energy Technology	6.0 hp	Second cycle

Conditionally elective courses

Course code	Course name	Credits	Edu. level
MJ2412	Renewable Energy Technology, Advanced Course	6.0 hp	Second cycle
MJ2426	Applied Heat and Power Technology	6.0 hp	Second cycle
MJ2438	Modeling of Energy Systems - Heat and Power Generation	6.0 hp	Second cycle

Supplementary information

Course list: Information is based upon the curriculum for academic year 2016/2017. Changes may occur.

Conditionally elective courses: chose at least 12 credits.

Year 2

Mandatory courses (18.0 Credits)

Course code	Course name	Credits	Edu. level
MJ2409	Applied Energy Technology, Project Course	9.0 hp	Second cycle

MJ2494	Polygeneration	9.0 hp	Second cycle

Optional courses

Course code	Course name	Credits	Edu. level
EG2340	Wind Power Systems	7.5 hp	Second cycle
ME2086	Global Energy Markets and Systems in Transition	6.0 hp	Second cycle
MJ2460	Green Building - Concept, Design, Construction and Operation	6.0 hp	Second cycle
MJ2462	Achieving Energy Efficiency in Existing Buildings	6.0 hp	Second cycle
MJ2503	Small Scale Polygeneration	6.0 hp	Second cycle

Conditionally elective courses

Course code	Course name	Credits	Edu. level
MJ2429	Turbomachinery	6.0 hp	Second cycle
MJ2477	Energy Policy and Planning	6.0 hp	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
MJ2480	Introductions to Computational Fluid Dynamics and Mathematics	6.0 hp	Second cycle
MJ2502	Industrial Dynamics of Innovation in Combined Energy Systems Replaces MJ2496	6.0 hp	Second cycle

Supplementary information

MJ2470 Climate Change Mitigation Tools is dormant for the study year 2017-2018.

MJ2496 will be replaced by MJ2502 from fall semester 2018

Track, Smart Electrical Networks and System (SENS)

Year 1

Mandatory courses (43.5 Credits)

Course code	Course name	Credits	Edu. level
EG2100	Power System Analysis	6.0 hp	Second cycle
EI2455	Smart Electrical Networks and Systems	7.5 hp	Second cycle

EI2600	Innovation and Entrepreneurship in Electric Power Engineering	6.0 hp	Second cycle
EI2610	Industrial Innovation Project	12.0 hp	Second cycle
EJ2201	Electrical Machines and Drives	6.0 hp	Second cycle
EJ2301	Power Electronics	6.0 hp	Second cycle

Conditionally elective courses

Course code	Course name	Credits	Edu. level
AK2030	Theory and Methodology of Science (Natural and Technological Science) Conditionally elective advanced course	4.5 hp	Second cycle
EG2110	Power System Stability and Control Conditionally elective advanced course	7.5 hp	Second cycle
EG2200	Power Generation Operation and Planning Conditionally elective basic course	6.0 hp	Second cycle
EG2210	Electricity Market Analysis Conditionally elective advanced course	7.5 hp	Second cycle
EG2220	Power Generation, Environment and Markets Conditionally elective advanced course	7.5 hp	Second cycle
EH2221	The Sustainable Electric Power Engineer Conditionally elective advanced course	1.5 hp	Second cycle
EH2741	Communication and Control in Electric Power Systems Conditionally elective basic course	6.0 hp	Second cycle
EH2745	Computer Applications in Power Systems Conditionally elective advanced course	4.5 hp	Second cycle
EH2770	IT Management with Enterprise Architecture I Conditionally elective advanced course	7.5 hp	Second cycle
EI2430	High-voltage Engineering	7.5 hp	Second cycle
EI2436	Power Grid Technology and Substation Design Conditionally elective basic course	6.0 hp	Second cycle
EI2440	Electrotechnical Design	7.5 hp	Second cycle
EI2490	Seminar Course in Electrotechnical Design and High Voltage Equipment Conditionally elective advanced course	1.5 hp	Second cycle
EJ2420	Seminars in Electrical Machines and Power Electronics Conditionally elective advanced course	1.5 hp	Second cycle
EL2450	Hybrid and Embedded Control Systems Conditionally elective advanced course	7.5 hp	Second cycle

Supplementary information

Course list: Information is based upon the curriculum for academic year 2016/2017. Changes may occur.

The program consists of mandatory and conditionally elective.

These courses are conditionally elective basic courses in Electric Power Engineering. Select a minimum of 6 credits from the conditionally elective courses following: EG2200, EH2741, EI2436 for your degree requirements.

These courses are conditionally elective advanced courses in Electric Power Engineering. Select a minimum of 10,5 credits from the conditionally elective advanced courses following: EH2221, AK2030, EL2450, EH2745, EH2770, EG2210, EG2220, EG2410, EI2490, EJ2420, EG2110 for your degree requirements.

Track, Smart Cities (SMCS)

Year 1

Mandatory courses (40.5 Credits)

Course code	Course name	Credits	Edu. level
AL2115	Transdisciplinary Approaches for System Innovations	7.5 hp	Second cycle
EG2100	Power System Analysis	6.0 hp	Second cycle
EH2741	Communication and Control in Electric Power Systems	6.0 hp	Second cycle
EJ2301	Power Electronics	6.0 hp	Second cycle
MJ2443	Heating, Cooling and Indoor Climate	6.0 hp	Second cycle
MJ2686	Smart Cities and Climate Mitigation Strategies, Larger Course - Project Based	9.0 hp	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
AI2155	Urban Economics and Cost Benefit Analysis	7.5 hp	Second cycle
AL2130	Waste Management	7.5 hp	Second cycle
AL2160	Environmental Management	7.5 hp	Second cycle
EG2110	Power System Stability and Control	7.5 hp	Second cycle
EG2210	Electricity Market Analysis	7.5 hp	Second cycle
EH2745	Computer Applications in Power Systems	4.5 hp	Second cycle
EH2770	IT Management with Enterprise Architecture I	7.5 hp	Second cycle
EI2600	Innovation and Entrepreneurship in Electric Power Engineering	6.0 hp	Second cycle
EJ2201	Electrical Machines and Drives	6.0 hp	Second cycle
EJ2230	Control in Electrical Energy Conversion	6.0 hp	Second cycle
ME2016	Project Management: Leadership and Control	6.0 hp	Second cycle
ME2063	Team Leadership and Human Resource Management	6.0 hp	Second cycle
MJ1402	Introduction to Energy Technology	3.0 hp	First cycle
MJ2380	Introduction to Energy Systems Analysis and Applications	9.0 hp	Second cycle
MJ2410	Energy Management	6.0 hp	Second cycle

MJ2411	Renewable Energy Technology	6.0 hp	Second cycle
MJ2615	Introduction to Industrial Ecology, larger course	7.5 hp	Second cycle

Supplementary information

Course list: Information is based upon the curriculum for academic year 2016/2017. Changes may occur.

Select a minimum of (3 cr.) the recommended elective courses.

Year 2

Mandatory courses (43.5 Credits)

Course code	Course name	Credits	Edu. level
EI2600	Innovation and Entrepreneurship in Electric Power Engineering	6.0 hp	Second cycle
MJ2685	Smart Cities and Climate Mitigation Strategies- Project Based	7.5 hp	Second cycle
MJ273X	Degree Project in Industrial Ecology, Second Cycle	30.0 hp	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
AF2507	Sustainable Buildings - Concept, Design, Construction and Operation	7.5 hp	Second cycle
AG2116	City Networks in Regional Contexts	7.5 hp	Second cycle
AG2806	Environmental Aspects of the Built Environment	7.5 hp	Second cycle
AH2170	Transport Data collection and Analysis	7.5 hp	Second cycle
AL2181	Environmental System Analysis and Decision-making	7.5 hp	Second cycle
EH2720	Management of Projects	7.5 hp	Second cycle
EJ2201	Electrical Machines and Drives	6.0 hp	Second cycle
MJ2382	Energy Data, Balances and Projections	6.0 hp	Second cycle
MJ2615	Introduction to Industrial Ecology, larger course	7.5 hp	Second cycle

Supplementary information

Course list: Information is based upon the curriculum for academic year 2014/2015. Changes may occur.

For students starting year 2 in the fall of 2013-14

At least 3-4 (22,5 cr) of the recommended elective courses should be selected

Appendix 2: Specialisations

Master's Programme, Energy Innovation, 120 credits (TIETM), Programme syllabus for studies starting in autumn 2017

Track, Nuclear Energy (NUEY)

This specialization deals nuclear energy engineering. The track is run in close collaboration with industrial partners and provides the latest trends in innovation in nuclear energy.

Track, Renewable Energy (RENE)

This specialization focuses on the renewable technologies where the partners of KIC InnoEnergy excel, such as wind energy, concentrated solar thermal power, solar photovoltaic energy, ocean energy, hydro power and geothermal energy.

Track, Smart Electrical Networks and System (SENS)

This education takes a starting point in the traditional education around electric power engineering, but turns its focus towards the electric power grid of the future -that is 'smart grids' - and how new concepts and ideas can lead to innovations within the framework of smart electrical networks and systems (smart grids).

Track, Smart Cities (SMCS)

This specialization deals with the concepts of “Smart Cities” based on scientific literature and reports from case studies.