ASIIN Seal & European Labels

Accreditation Report

Bachelor's Degree Programme
Environmental Technology
Energy Technology

Master's Degree Programme
Sustainability Science and Solutions
Energy Technology
Energy Systems

Provided by
Lappeenranta University of Technology, Finland

Version: 09 July 2018

Table of Content

A About the Accreditation Process

Name of the degree programme (in original language)	(Official) English translation of the name	Labels applied for [1]	Previous accreditation (issuing agency, validity)	Involved Technical Committees (TC)[2]
Energiatekniikan kandidaatin tutkinto-ohjelma	Ba Energy Technology	ASIIN, EUR-ACE® Label	ASIIN, 29.6.2012 – 30.9.2017	01, 02
Energiatekniikan diplomi-insinöörin tutkinto-ohjelma	Ma Energy Technology	ASIIN, EUR-ACE® Label	ASIIN, 28.6.2011 – 30.9.2016	01, 02
Ma Sustainability Science and Solutions	Ma Sustainability Science and Solutions	ASIIN, EUR-ACE® Label		01, 02, 06
Ympäristötekniikan kandidaatin tutkinto-ohjelma	Ba Environmental Technology	ASIIN, EUR-ACE® Label	ASIIN, 29.6.2012 – 30.9.2017	01, 02, 06
Master's programme in Energy Systems	Ma Energy Systems	ASIIN, EUR-ACE® Label	ASIIN, 28.6.2011 – 30.9.2016	01, 02, 06

Date of the contract: 18.08.2016

Submission of the final version of the self-assessment report: 23.02.2017

Date of the onsite visit: 05. - 06.04.2017

at: Lappeenranta University of Technology

[1] ASIIN Seal for degree programmes; EUR-ACE® Label: European Label for Engineering Programmes

[2] TC: Technical Committee for the following subject areas: TC 01 – Mechanical Engineering/Process Engineering; TC 02 – Electrical Engineering/Information Technology; TC 06 - Industrial Engineering.

Peer panel: Prof. Dr. Burkhard Egerer, Technical University of Applied Sciences Nuernberg; Prof. Dr. Olav Hohmeyer, Europe University of Flensburg; Prof. Dr. Katrin Lehmann, Brandenburg University of Technology; Mr. Juho Tamminen, Aalto University, Master's programme chemical engineering; Dr. Matthias Wunderlich, Robert Bosch Automotive Steering GmbH.
Representative of the ASIIN headquarter: Dr. Thomas Lichtenberg
Responsible decision-making committee: Accreditation Commission for Degree Programmes
Criteria used: European Standards and Guidelines as of 10.05.2015 ASIIN General Criteria, as of 10.12.2015 Subject-Specific Criteria of Technical Committee 01 – Mechanical Engineering/Process Engineering as of 09.12.2011 Subject-Specific Criteria of Technical Committee 02 – Electrical Engineering/Information Technology as of 09.12.2011 Subject-Specific Criteria of Technical Committee 06 – Industrial Engineering as of 09.12.2011

B Characteristics of the Degree Programmes

a) Name	Final degree (original/English translation)	b) Areas of Specialization	c) Corresponding level of the EQF[3]	d) Mode of Study	e) Double/Joint Degree	f) Duration	g) Credit points/unit	h) Intake rhythm & First time of offer
Ba Energy Technology	Tekniikan kandidaatin tutkinto / Bachelor of Science (Technology)	Compulsory specialisation areas: The physical basic phenomena related to energy technology, energy conversion processes and machines and equipment related to energy conversion processes	Level 6	Full time	/	6 Semester	180 ECTS Credit points	Autumn semester
Ma Energy Technology	Diplomi-insinöörin tutkinto / Master of Science (Technology)	Specialisations: Energy Conversion, Power Engineering, Nuclear Energy Engineering	Level 7	Full time	/	4 Semester	120 ECTS Credit points	/Autumn semester
Ma Energy Systems	Master of Science (Technology)	Specialisations: Bioenergy Technology, Nuclear Engineering	Level 7	Full time	/	4 Semester	120 ECTS Credit points	Consecutive / Autumn semester
Ba Environmental Engineering	Tekniikan kandidaatin tutkinto / Bachelor of Science (Technology)	/	Level 6	Full time	/	6 Semester	180 ECTS Credit points	Autumn semester
Ma Sustainability Science and Solutions	Master of Science (Technology)	/	Level 7	Full time	/	4 Semester	120 ECTS Credit points	Consecutive / Autumn semester

For the Bachelor's degree programme Energy Technology the institution has presented the following profile in the self-assessment report:

[3] EQF = The European Qualifications Framework for lifelong learning

„After completing the Bachelor's programme, students will be able to

- describe the basic physical phenomena related to energy technology Bachelor's and Master's programmes in Energy Technology and Environmental Technology
- apply basic equations of thermal engineering in the examination of energy conversion related processes
- describe the structure and operation principles of the equipment related to energy technology (boilers, turbines, compressors, fans, heat exchangers)
- calculate operating values of equipment and define their measurement principles
- describe the operation principles of various energy conversion processes
- compare the applicability of various energy conversion processes to different applications from technological, economic and environmental perspectives
- acquire information from various sources and evaluate their quality and reliability
- communicate both orally and in writing in the national and international context
- work in projects as a specialist in energy technology. "

For the Master's degree programme Energy Technology the institution has presented the following profile in the self-assessment report:

"After the completion of the Master's Programme in Energy Technology, students will be able to:

- analyse, design and select energy conversion processes for different applications, taking technological, economical, environmental and societal aspects into account
- apply and develop mathematical models to solve energy technology problems
- manage and organise both national and international projects
- communicate and operate in academic and research environments."

For the Master's degree programme Energy Systems the institution has presented the following profile in the self-assessment report:

"After the completion of the Master's Degree Programme in Energy Systems, students will:

- be able to demonstrate a comprehensive understanding of the important technologies, practical applications, processes and actions concerning energy generation, power systems and energy markets, and the use of energy

- have adopted the principles of life cycle thinking and sustainable development in the domain of energy and the environment
- demonstrate a critical understanding of relevant theories and techniques, problem-solving skills, and the ability to use knowledge, equipment and tools independently for the design and development of practical applications
- be able to work with others in task-oriented groups, productively participating and interacting in the group
- be able logically to think through a problem and solve it, to contribute to innovative thinking, and to unambiguously communicate knowledge and solutions to the energy community and society, orally and in writing."

For the Bachelor's degree programme Environmental Technology the institution has presented the following profile in the self-assessment report:

"Students who have completed their BSc degree in Environmental Technology are able to:

- define the fields of environmental technology, including their basic concepts, the central methods available, and related theories
- identify different emissions and their sources
- discuss the meaning of environmental technology, including its possibilities, challenges, and future visions also with experts from other fields
- follow and interpret the current legislation, and independently apply the legal norms related to environmental issues to practical work
- work in projects and teams consisting of experts from different fields
- report (e.g. on corporate environmental and social responsibility issues) in their mother tongue and in English
- gather and analyse scientific information related to environmental issues, and analyse the reliability of the sources."

For the Master's degree programme Sustainability and Science Solutions the institution has presented the following profile in the self-assessment report:

Students who complete their M.Sc. (Tech.) degree in Sustainability Science and Solutions

will be able to:

- take responsibility for managing environmental issues
- take responsibility for developing environmental issues

- anticipate the importance of sustainability challenges in the future
- work as a public environmental authority.

To describe the competences more precisely, the students who complete the degree will be able to:

- recognise the most significant environmental impacts of products and processes and their importance in terms of business
- understand the requirements of systemic change
- analyse how competitive in terms of environmental impacts and costs a certain technology, product or service is in different operating environments
- assess the technical possibilities of industrial, service, community, and primary production processes and systems to minimise environmental impacts
- explain the complex interdependencies of both local and global environmental problems
- apply theories and the most recent scientific knowledge to solve problems involving environmental aspects
- work as an environmental expert in a range of decision-making situations and produce and convey information to support stakeholders in environmental decisionmaking
- adopt and innovate new technical solutions to develop the environmental sector."

C Peer Report for the ASIIN Seal[4]

1. The Degree Programme: Concept, content & implementation

Criterion 1.1 Objectives and learning outcomes of a degree programme (intended qualifications profile)

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Study Guides for each degree programme under review
- Subject specific Diploma Supplements for each degree programme
- List of all degree programmes under accreditation: http://www.lut.fi/web/en/school-of-energy-systems/studies (10.04.2017)
- Website for Ma Energy systems: http://www.lut.fi/web/en/admissions/masters-studies/msc-in-technology/energy-technology/energy-systems (10.04.2017)
- Website for Ma Sustainability Science and Solution: http://www.lut.fi/web/en/admissions/masters-studies/msc-in-technology/environmental-engineering/sustainability-science-and-solutions (10.04.2017)

Preliminary assessment and analysis of the peers:
The peers welcome that each degree programme has its own website either in Finnish for the programmes taught in Finnish or in English for those taught in English; some pages are even available in German. The peers positively note that the intended learning outcomes of the English programmes are published on the website. Assuming that this also applies to the Finnish websites the peers conclude that the programme objectives and the learning outcomes are made available to interested stakeholders. Looking at the Diploma Supplements, the peers find a reference to the Transcript of Records with respect to the programme objectives and the learning outcomes. The peers kindly ask LUT to provide the

[4] This part of the report applies also for the assessment for the European subject-specific labels. After the conclusion of the procedure, the stated requirements and/or recommendations and the deadlines are equally valid for the ASIIN seal as well as for the sought subject-specific label.

Transcript of Records for all degree programmes. The self-assessment report provides general learning objectives applicable to all Bachelor's and Master's Programmes which are appropriate for the respective degree programmes as the peers confirm.

The peers refer to the **Subject-Specific Criteria (SSC)** of the Technical Committee Mechanical Engineering / Process Engineering as well as to the SSC of the Technical Committee Electrical Engineering/Information Technology as a basis for judging whether the intended learning outcomes of the two Bachelor's programmes and the three Master's programmes, as defined by LUT, correspond to the exemplary constituted learning outcomes of these Technical Committees. The auditors examine the areas of competence as set forth by the SSC for degree programmes and come to the following conclusions:

The learning outcomes of the Bachelor's degree programme Energy Technology include that students shall be able to describe the basic physical phenomena related to energy technology which implies a broad and sound knowledge in *mathematics, science* and *engineering* to understand the complex phenomena of energy technology. In addition, the students should be able to describe the structure and operation principles of the equipment related to energy technology (boilers, turbines, compressors, fans, heat exchangers) and to calculate operating values of equipment and define their measurement principles which implies that students gain competences in the field of *Engineering Analysis*, as the peers concluded. Students shall also be able to compare the usefulness of various energy conversion processes to different applications from technological, economic and environmental perspectives which leads to competences in E*ngineering Practice* as the peers understand. However, the peers judge that competences in the field of *Engineering Design* are missing because they do not find any objective describing the competence to design complex machinery, devices, EDP programmes or processes corresponding to the status of their knowledge. The peers highlight that this is a key competence for engineers which must be integrated into the learning objectives of this degree programme. Furthermore, graduates shall be able to acquire information from various sources and evaluate their quality and reliability which is in line with the competence of *Investigations and Assessment* as the peers agree. When it comes to so called *Transferable Skills* the peers understand that the students shall communicate both orally and in writing in the national and international context and work in projects as a specialist in energy technology.

The learning outcomes of the Master's degree programme Energy Technology build on the knowledge and competences obtained in the Bachelor's programme as the graduates shall analyse, design and select energy conversion processes for different applications, taking technological, economical, environmental and societal aspects into account. The peers highlight that this requires advanced knowledge of mathematic-scientific and engineering principles which is in line with the SSC of ASIIN. The peers welcome that students shall be

able to apply and develop mathematical models to solve energy technology problems which develops competences in the field of *Engineering Analysis*. However, like in the Bachelor's programme, the peers cannot see that students will acquire competences in the field of *Engineering Design;* this should be amended as the peers emphasize. The management and organisation of both national and international projects requires that the students are able to identify, to find and to procure the necessary information. The competence to communicate and to operate in academic and research environments is an important *Transferable Skill*; these non-technical competences could be further elaborated as the peers point out. The peers understand that the general learning outcomes for all Master's programmes as outlined in the self-assessment report cover particularly non-technical skills like good communication and language skills as well as presentation, cultural and leadership skills. The peers agree that these *Transferable Skills* are valid for all Master's programmes including this one; however, they advise programme coordinators to critically reflect if this programme requires specific non-technical skills which do not apply to other Master's programmes.

Although the learning outcomes of the Master's Programme in Energy Systems are different from the Master Energy Technology the peers observe that both programmes have a strong focus on technology. The qualification profile of the Master Energy Systems includes that the students shall be able to demonstrate a comprehensive understanding of the important technologies, practical applications, processes and actions concerning energy generation, power systems and energy markets, and the use of energy which requires *consolidated knowledge of mathematic-scientific and engineering* principles. The students shall also acquire a critical understanding of relevant theories and techniques, problem-solving skills, and the ability to use knowledge, equipment and tools independently for the design and development of practical applications. The peers understand that competences in the field of *Engineering Analysis* shall be obtained and also the notion of *Design* is mentioned but the peers think that competences in the field of *Engineering Design* should be highlighted more prominently in the learning objectives. According to the learning outcomes in the self-assessment report the graduates shall adopt the principles of life cycle thinking and sustainable development in the domain of energy and the environment as the peers positively note. Looking at the *Transferable Skills* the students shall be able to work with others in task-oriented groups, productively participating and interacting in the group and be able to logically think through a problem and solve it, to contribute to innovative thinking, and to unambiguously communicate knowledge and solutions to the energy community and society, orally and in writing. The peers judge these competences positively and are of the opinion that leadership skills are mentioned appropriately in the overarching objective applicable to all Master programmes. In summary, the peers come to the conclusion that this

degree programme has a strong focus on energy technology; however, in a Master's degree in Energy Systems the peers would expect more system-related competences. Therefore, the peers judge that this programme is very similar to the Master's in Energy Technology and the differences do not become understandable in the learning outcomes.

The learning outcomes of the Bachelor's Programme in Environmental Technology explain that students will acquire basic knowledge, skills and competences needed to assess the environmental impact of product chains and communities, and learn to analyse the use of natural and other resources throughout the product life cycle. It is plausible for the peers that the students shall gain extensive technical knowledge in the field of engineering, *mathematics and natural science*. The peers understand that the students shall be able to follow and interpret the current legislation, and independently apply the legal norms related to environmental issues to practical work. The peers agree that this requires competences in *Engineering Analysis*; however, the aspect of problem-solving could be emphasized more strongly as the peers point out. Like for the other programmes, the peers are missing a clear competence description of *Engineering Design* and highlight that students should be able to demonstrate the ability to design engineering devices in the field of environmental technology. The peers welcome that students shall be able to gather and analyse scientific information related to environmental issues, and assess the reliability of the sources. This clearly covers the required competences in *Investigations and Assessment* as the peers confirm. The peers comprehend that the students shall be able to independently apply environmental issues to practical work; the peers can see the reference to *Engineering Practice* as demanded in the ASIIN criteria although the peers hold the opinion that the practical competences could be elaborated in more depth. The peers appreciate the interdisciplinary approach that students work in projects and teams consisting of experts from different fields and understand that this leads to *Transferable Skills* in terms of team working and communication. The competence to discuss the meaning of environmental technology, including its possibilities, challenges, and future visions also with experts from other fields is outlined in more detail in the learning outcomes which is also appreciated by the peers. In addition, the students shall acquire language competences. The peers see that the intended learning outcomes are, to a large extent, in line with the requirements of the SSC; however, especially the competences in problem solving and engineering design need to be described in more detail.

The learning outcomes of the Master's degree programme Sustainability Science and Solutions outline that graduates shall be able to explain the complex interdependencies of both local and global environmental problems and to assess the technical possibilities of industrial, service, community, and primary production processes and systems to minimise

environmental impacts. This requires extensive advanced knowledge of *mathematic-scientific and engineering principles* of engineering as the peers confirm and therefore they see that the students shall acquire competences in the field of *Knowledge and Understanding*. The peers also welcome that students shall be enabled to apply theories and the most recent scientific knowledge to solve problems involving environmental aspects which is in line with key competences from the field of *Engineering Analysis* as they confirm. *Engineering Design* is also missing in this study programme as the peers note, although the competence to adopt and innovate new technical solutions to develop the environmental sector is an indication into the right direction. Graduates shall work as environmental experts in a range of decision-making situations and produce and convey information to support stakeholders in environmental decision-making. The peers understand that this competence is supposed to foster *Engineering Practice* and to enable students to work successfully in their field of competence. The students shall be able to apply theories and the most recent scientific knowledge to environmental aspects which implies that students know how to identify, find and procure necessary information which is in line with the ASIIN criteria of *Investigation and Assessment*. The *Transferable Skills* are not explained individually for this Master's programme but are subsumed under the general objectives for all Master's courses. Like for the Master Energy Technology the peers recommend to critically assess if this programme does require any specific non-technical skills.

The peers summarise that the SSC are by and large covered in the learning objectives of all five degree programmes under review considering the stated deficiencies with regard to *Engineering Design*. The peers highlight that the educational objectives/learning outcomes have to include competences in the field of Engineering (Processes) Design.

Furthermore, the University applied for the EUR-ACE® (European Accredited Engineer) Label. The EUR-ACE® Label is a quality certificate for engineering degree programmes and is recognized Europe-wide. During the accreditation process, the reviewers verified whether the engineering degree programs comply with the criteria fixed in the EUR-ACE® Framework Standards. The Subject-Specific Criteria (SSC) of the Technical Committee for Mechanical Engineering and Process Engineering are closely linked to the EUR-ACE® Framework Standards; consequently, the analysis of the Subject-Specific Criteria encompasses the EUR-ACE® Framework Standards. The peers confirm that the EUR-ACE® Framework Standards regarding the intended learning outcomes are, considering the shortcomings as indicated in the previous sections, for the First (Bachelor) and Second (Master) Cycle Degree Programmes in line with the Bologna Declaration.

Employment opportunities for graduates

Employment opportunities for graduates for the Master's programmes under review are described by representatives of LUT Master's degree as excellent. In the discussion, the business representatives stress that they gladly employ Master's graduates from LUT as they have made very good experiences and think that they are well prepared for the requirements of the labour market. Statistics provided by LUT also show that graduates normally find an occupation adequate to their level of education within a few months after graduation. However, almost 100% of the graduates of Bachelor's degree programmes pursue a Master's degree because they do not expect to find an appropriate employment after completing a Bachelor's degree. The peers know that this matter had been discussed during the first accreditation procedure and understand that in Finland Bachelor's graduates usually come from Universities of Applied Sciences, and graduates from Universities are supposed to hold a Master's degree. In Finland's university engineering education system, the Bachelor's degree is generally considered as an intermediate phase in the progress towards a Master's degree and therefore the demand from industry is rather low for Bachelor's graduates from universities. Some representatives from businesses explain that they might consider employing graduates with a Bachelor's degree but the competences of a Bachelor's degree are not fully clear to employers. The peers understand that this is a Finland-wide phenomenon and cannot be changed by one individual university. LUT explains that some progress has been made to give Bachelor's graduates more practical skills and develop them towards employability. The peers acknowledge the efforts taken by LUT and see this as a long-term development. Therefore the peers repeat the recommendation that had been made during the first accreditation and recommend to push forward the nation-wide discussion about sharpening and separating the Bachelor's from the Master's degree to better align them with the Bologna process.

Further development of degree programmes

LUT staff members as well as business representatives confirm that there is a close cooperation and communication between LUT and businesses. Many graduates who start working at a company keep the contact with the university and support their alma mater as far as possible. Many students do internships or final theses at private companies and the business partners give feedback on the performance and competences of the student; this also applies to the development of new programmes or the revision of all programmes where businesses can give their input which is considered at LUT for the process of formulating and further developing the objectives and learning outcomes and curricular content.

Criterion 1.2 Name of the degree programme

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Study Guides for each degree programme under review

Preliminary assessment and analysis of the peers:
The peers understand that some changes regarding the names of the degree programmes have taken place since the first accreditation. The former Master "Environmental Technology" was renamed into Sustainability Science and Solutions. LUT explains that this name was developed as a consequence of a consulting process. The peers agree that the name sounds attractive and appealing to potential students. However, the name itself is not straightforward in terms of giving external stakeholders or employers a clear understanding of the competences of the graduates. The graduates add that they usually need to provide a longer explanation of their competences if they apply somewhere. Notwithstanding, when looking at the programme objectives and the curriculum, the peers confirm that the intended learning outcomes and the curriculum impart key competences that are in line with the name of the programme. Therefore, the name and the content of the programme are not contradictory and LUT needs to gain more experiences with this programme to see if it is attractive for students. From a formal point of view, the peers have no objections. However, they wonder why the preceding Bachelor's programme Environmental Technology has kept its name.

As indicated under criterion 1.1 the peers do not comprehend the differences between the two Master's programmes Energy Technology and the new Master Energy Systems except for the fact that one is taught in English and the other one in Finnish. Based on the programme objectives and the intended learning outcomes, both programmes have a very technical focus (compare criterion 1.1). This impression is also underpinned by the analysis of the curricula (compare criterion 1.3). The peers underline their impression that the Master Energy Systems is a Master with a technological focus and the name is misleading for students and employers; the peers wonder if the two masters could be merged and offered in two languages. In any case, the peers conclude that LUT has to ascertain that the name of the degree programme Master Energy Systems, its intended learning outcomes and its content correspond with each other. The names of the other programmes are plausible as the peers note.

Criterion 1.3 Curriculum

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Study Guides for each degree programme under review
- Module descriptions: Study guides for all degree programmes include module descriptions
- Curricular overview of all degree programmes, appendices 4-8 of SAR
- List of all degree programmes under accreditation: http://www.lut.fi/web/en/school-of-energy-systems/studies (10.04.2017)
- Website for Ma Energy systems: http://www.lut.fi/web/en/admissions/masters-studies/msc-in-technology/energy-technology/energy-systems (10.04.2017)
- Website for Ma Sustainability Science and Solution: http://www.lut.fi/web/en/admissions/masters-studies/msc-in-technology/environmental-engineering/sustainability-science-and-solutions (10.04.2017)

Preliminary assessment and analysis of the peers:
The overall structure of the Bachelor's degree Programmes on the one and the Master's degree Programmes on the other hand is very similar. Both Bachelor programmes encompass general studies, language and communication studies, intermediate specialisation studies, minor studies and elective studies. All classes in the Bachelor's degree programmes are taught in Finnish. This approach is continued in the Master programmes on a higher and specialised level. With regard to the "minor studies in technology", Master students can choose either to keep up the area of technology they studied in their B.Sc. on an advanced level or change the subject. The peers learn that the students must not choose the minor courses randomly, but according to fixed packages. By this pre-structuring and in-depth guidance in the preparation of the individual study plans LUT ensures that the minor studies correspond with the overall objectives as well as the intended level of qualification.

As outlined under criterion 1.1, the auditors could see that the intended learning outcomes are, with some limitations, in line with the Subject-Specific Criteria (SSC) of the Technical Committees Mechanical and Process Engineering and Electrical Engineering. The peers base their assessment whether the curricula of the different degree programmes are suitable to achieve the intended learning outcomes on the module descriptions and the

study plans. The overall objectives and intended learning outcomes for the degree programme are systematically substantiated in modules and it is clear for the peers which knowledge, skills and competences students will acquire in each module.

The general studies of the Bachelor Energy Technology include modules like “Introduction to Studies of Energy Technology”, “Fundamentals of Engineering Thermodynamics”, “Fundamentals of Energy Economics”, “Basics of Electric Engineering”, different courses in Mathematics, “Basics of Mechanics”, “Thermal Physics”, “Wave Motion and Wave Phenomena”, and “Electricity and Magnetism”. The peers conclude that the students shall obtain a broad and *sound knowledge in Mathematics, Science and Engineering* to understand the complex phenomena of Energy Technology. In addition, the students shall learn the physical basic phenomena related to energy technology which comprises modules like “Fundamentals of Heat Transfer”, “Engineering Thermodynamics”, “Fluid Dynamics I+II”, “Basic Course in Strength of Materials”, and “Measurements in Energy Technology”. The peers confirm that these modules are suitable to teach competences in the field of *Engineering Analysis*. Even though the peers note that the learning outcomes do not adequately refer to competences in the field of *Engineering Design*, the peers comprehend that in the curriculum the design competences are connected to the processes of energy conversion and not to the construction of components and machines. LUT agrees that engineers should have construction competences for machines and components but this is taught in the Mechanical Engineering Department. All students have three compulsory specialisation areas: The physical basic phenomena related to energy technology, energy conversion processes and machines and equipment related to energy conversion processes. In the context of these specialisation areas the *Design of Processes* is integrated in elective modules like “Pumps, Blowers, Fans and Compressors”, “Introduction to Nuclear Engineering”, “Introduction to Power Plant Engineering”, “Introduction to Combustion and Boiler Technology”, “Renewable Energy”, and “Applied Thermodynamics”. The peers conclude that *Process Engineering Design* competences are included in the curriculum. Competences in the field of *Investigations and Assessment* are covered in the Bachelor’s thesis and projects as the peers agree. When it comes to *Engineering Practice* the peers understand that modules like “Practical Measurements in Energy Technology”, “Laboratory Course of Thermodynamics”, “Laboratory Course of Heat Transfer”, and “Applied Thermodynamics Laboratory Course” provide a thorough introduction to the practical side of Energy Technology. The Bachelor’s theses are normally written at LUT and hardly in industry; consequently, the Bachelor’s theses do not support the development of practical engineering competences in a business environment (compare criterion 3). The peers discuss with the programme coordinators about the minimum length of the internship (at least four weeks, 2 ECTS cred-

its). They learn that students should get some practical experience in a real working environment. They have to write a short report about the internship which has to be approved by the teacher, but the internship can be done in any area; there does not have to be a connection to the specific field of studies. According to the programme coordinators, the reason for the low requirements is that the students sometimes do not find suitable internships for a longer period. The students confirm that it is challenging to find a subject specific internship but almost all the Bachelor's students work during the summer because they must earn money to finance the cost of living during their studies. The peers understand the reasons for the current regulation concerning the internship in the Bachelor's degree programmes, but notwithstanding they think that practical work experiences in the professional field are very important in order to properly prepare the students for the demands of the labour market. An internship in any field is only of limited help and therefore they recommend to strengthen the mandatory internship in relevant industrial sectors and to adjust the credit points accordingly. The peers are doubtful if the *two focal areas* like biomass and nuclear energy are sufficient for the future needs of the country. LUT explains that there are more activities in other programmes like wind and solar energy in electrical engineering programmes. Students can take these courses too. Following a strategic discussion at LUT the decision was made to provide thorough basics in this programme that can be built on in consecutive programmes. The peers take note of this explanation. The peers wonder why no credit points are awarded to the module "Scientific Writing in Finnish" and learn that this module is not part of the Bachelor programme although it is mandatory. The peers point out that it is contradictory to have a mandatory module in the curriculum with no credit points. This module could easily be integrated into the module Bachelor's Thesis Seminar of Energy Technology, for example. The peers advise to find a sensible solution for this matter. *Transferable Skills* are integrated into the teaching methods of the modules. The students have to carry out a number of group works; the teams are normally defined by the teachers to make sure to have multinational and multidisciplinary teams. When forming the groups, the students have to make group rules, write them down and give them to the teacher who may add some rules. In the groups they have to write reports and make presentations. Students from other groups are required to give critical feedback. The peers welcome this approach and agree that *Transferable Skills* are properly taught in the curriculum.

The Bachelor Environmental Technology also covers a number of subject-specific and more fundamental courses like Introduction to Studies of Environmental Technology, Fundamentals of Engineering Thermodynamics, General Chemistry, Basic Course in Environmental Technology, Basics of Electric Engineering, and a number of different courses of Mathematics. The peers confirm that competences in the field of *Knowledge and Understanding* are

integrated into the curriculum. Competences in the field of *Engineering Analysis* shall be obtained in modules like Engineering Thermodynamics, Energy Efficiency Management of Buildings, Basics of Mechanics, Thermal Physics, Wave Motion and Wave Phenomena, or Electricity and Magnetism. Like in the Bachelor Energy Technology the peers also indicate for this programme that competences in the field of *Engineering Design* are not properly outlined in the learning outcomes; however, like for the other Bachelor's Programme, the peers understand that the focus is more on *Engineering Process Design*. The corresponding elective modules to achieve these *Engineering Process Design* competences are Introduction to Nuclear Energy, Pumps, Blowers, Fans and Compressors, Applied Thermodynamics, Fluid Dynamics I+II, Introduction to Power Plant Engineering, Bio-energy, Electrical Safety, or Control Systems, Introduction. Hence, the peers agree that *Engineering Process Design* is properly covered in the curriculum. Like in the Bachelor Energy Technology, the peers conclude that competences in the field of Investigations and Assessment are covered in the project and the final thesis. A number of laboratory courses like Practical Measurements in Energy Technology, Measurements in Energy Technology, Environmental Measurements, Laboratory Course of Environmental Measurements and Safety in Chemistry Laboratory contribute to *Engineering Practice*; however, the limited extent of internships that are not necessarily connected to the professional field of the studies applies to this programme too and therefore the peers make the same recommendation. *Transferable skills* are also covered in the teaching methodology; additionally, this programme provides a number of modules like Introduction to Environmental Law or Climate Change which deliver additional transferable skills.

When examining the curricula of the two Master's programmes Energy Technology and Energy Systems the peers can see a lot of similarities and some differences. The core subjects of Energy Technology Programme cover modules like Power Plant Engineering, District Heating, Nuclear Power Plant Engineering or Turbomachinery whereas the Energy Systems Programme contains modules like Steam Boilers, Introduction to Sustainability or Numerical Methods in Heat Transfer. The peers confirm that both programmes include modules that provide *advanced knowledge of mathematic-scientific* and *principles of engineering* as well as competences in *Engineering Analysis*. For the Master Energy Technology a student has to choose studies from one of the three specialisation areas: Energy Conversion, Power Engineering or Nuclear Energy Engineering. Like in the Bachelor's Programmes, the focus is on Engineering Process Design and the modules that are taken by the students depend on the specialisation area. For the specialisation *Energy Conversion* students have to take mandatory courses like Advanced Topics in Modelling of Energy Systems, Advanced Modelling Tools for Transport Phenomena, Steam Boilers and Turbomachinery in Renewable Energy. For the specialisation *Power Engineering* modules like Pressure Equipment,

Steam Boilers, Energy Economics in Wood Processing Industry, Fundamentals of Energy Systems Planning or Planning of Energy Systems. For the third specialisation *Nuclear Energy Engineering* modules like Nuclear Reactor Design, Reliability Engineering, Nuclear Reactor Physics Methods, Theoretical Nuclear Thermal Hydraulics, and Nuclear Reactor Dynamics are required. The peers confirm that for all three specialisation areas sufficient *Engineering Design* competences are integrated in the curriculum. The Master Energy Systems offers two specialisations, namely Bioenergy Technology and Nuclear Engineering. The specialisation Bioenergy Technology offers mandatory modules like Turbomachinery in Renewable Energy, Energy Systems Engineering, Bioenergy Technology Solutions and Bioenergy which cover *Engineering Design* competences appropriately as the peers confirm; however, the peers note a strong focus on technological aspects with regard to the modules. The second specialisation in this Master Programme is *Nuclear Engineering* including modules like Nuclear Reactor Design, Reliability Engineering, Nuclear Reactor Physics Methods, Theoretical Nuclear Thermal Hydraulics, and Nuclear Reactor Dynamics which are identical with those modules offered in the Master Energy Technology. Especially for this specialisation the peers see a clear technological focus and wonder about the difference to the Master Energy Technology. As outlined under criterion 1.1 and 1.2, the peers think that the name Master Energy Systems and the learning outcomes as well as the curriculum need to be aligned. The peers confirm that the Master's Theses as well as modules like Academic Writing in English Course 1+2 develop competences in the field of *Investigations and Assessment*. When it comes to *Engineering Practice*, laboratories are offered and have to be carried out in the context of the respective specialisations. Internships are only elective and can vary between 2-10 credit points; internships have to take place in an institution that works in the professional field of the studies. Given the fact that most Master's Theses are written in a partner company the peers gain the conviction that an appropriate level of *Engineering Practice* is integrated into the curriculum. Like in the Bachelor's programmes multidisciplinary team projects with presentations and feedback mechanisms foster the development of non-technical skills. This is further supported by modules like Science, Technology and Society or Introduction to Sustainability.

The new Master Sustainability Science and Solutions results from a merger of two other Master's programmes; this merger had internal organisational reasons. The responsible persons for the programme explain that this programme combines different aspects of sustainability and looks at the products in the broader context. The name was developed as a consequence of a consulting process. Whether the name causes false expectations among students or employers cannot be judged yet as the programme is new. The peers examine the curriculum of the programme and understand that the programme includes modules like Advanced Course in Life Cycle Assessment, Energy Efficient Environment, Corporate

Responsibility and Management or Sustainable Innovation and System Transition which underpin the title of the programme with respective content. Based on the module descriptions the peers agree that *advanced knowledge of mathematic-scientific and engineering principles* are integrated into the curriculum. Based on the interest of the students, they can chose from different specialisation courses like Solid Waste Management Technology, Air Pollution Control, Sustainable Water Use, Indoor Climate Management of Buildings or Climate Finance and Carbon Markets which requires the development of *Engineering Analysis* competences that need to be developed in this context. Students are recommended to include in their elective studies especially courses from minor studies Global Energy Revolution, Design of Energy Systems and Competitiveness of Clean Technologies. Competences in the field of *Investigations and Assessment* are covered in the Master's Thesis and modules like Presenting in English and Academic Writing in English. Like for the other Master programmes, *Engineering Practice* can be obtained through a professional internship but the primary exposure to *Engineering Practice* will take place in the Master's Theses that will primarily be written in industry.

In summary, the peers conclude that even though the aspects of *Engineering Design* need to be elaborated in the learning outcomes, the curriculum shows clear evidence that competences of *Process Engineering Design* are being taught. Diverse teaching methods and multicultural and multidisciplinary study groups ensure that the students in all degree programmes will have good skills in team and project work, communication and languages, presentation, culture and leadership. However the differences between the two Master's Programmes Energy Technology and Energy Systems are not fully clear to the peers and they think that the name and the learning outcomes of the Master Energy Systems need to be harmonised. The peers also confirm that the curriculum corresponds largely to the exemplary learning objectives as pointed out in the subject-specific criteria of ASIIN; however, competences in the field of *Engineering Practice* should be strengthened in the curriculum.

Criterion 1.4 Admission requirements

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Finnish Universities Act (558/2009 and 428/2013)
- Guideline for the recognition of prior learning and credit transfer of September 1st 2014

- University Regulations on Education and the Completion of Studies, approved on 22nd June 2016
- Website „Studyinfo.fi“ (https://studyinfo.fi/wp2/en/, 10.04.2017)
- LUT/Admission (http://www.lut.fi/web/en/admissions, 10.04.2017)
- LUT – Study Guide 2015-2016. Study programs and courses in English (https://uni.lut.fi/en/c/document_library/get_file?uuid=262cffb3-fe5a-44ea-8408-d4a6e89757fa&groupId=10304, 10.04.2017)

Preliminary assessment and analysis of the peers:
The admission to LUT is regulated according to the Finnish Universities Acts (558/2009 and 428/2013) and is organized by joint application system (Studyinfo.fi) that is used by all Finnish universities. All relevant information is publically available on the respective website as well as on the website of LUT.

On Bachelor's level applicants are allowed to apply for at maximum six degree programmes at one or different universities or universities of applied sciences. Condition for an application is the completion of the Finnish matriculation examination, a three-year vocational degree or an equivalent international high school degree. Students can be selected based on their success in the Finnish matriculation examination or by their success in the entrance examinations. The entrance examinations are organized jointly by the seven technical universities in Finland. The entrance examination is based on the Finnish high school curriculum in mathematics, physics and chemistry. Prospective students must pass the entrance examination to be selected even if there are fewer applicants than places available. This guarantees the minimum required knowledge in natural sciences and mathematics of all first year students. The further details are regulated in Sections 36 and 37 of the Finnish Universities Act (558/2009).

Distinctive admission criteria for the Master's degree programmes do not exist: All students admitted to a Bachelor's degree programme in a University are also allowed to continue their academic studies in a Master's degree programme (as in all universities in Finland). Since 2016, students graduating with a Bachelor's degree may continue to any Master's degree programmes of the same area. The students have already to choose their field of study for the Master's programme when they are applying for the Bachelor's degree programme.

The students are encouraged to apply for a Master's degree programme as soon as their Bachelor's studies are finished and they are allowed to take Master's level studies even before their graduation, which assures a smooth transition from the Bachelor's studies to

the Master's studies. The peers inquire how LUT handles the applications of Master students from other countries. They learn that the Master's programmes are open for all graduates with a Bachelor's degree. The admission is based on the final grade of the Bachelor's degree (50%) and on an interview with the programme coordinator (50%). The interviews with international applicants are done via Skype. In addition, all applicants must provide an English language certificate. Bachelor's students from LUT are admitted automatically to the Master programmes without any further application or selection procedure. At LUT approximately 50% of the new Master's students are from Finland, whereas another 50% come from foreign countries. International students from outside the EU will have to pay a tuition fee of 10.000 € per year from next fall semester. The programme coordinators expect the number of international applications to drop but hope that the quality will improve.

The auditors confirm that the requirements and procedures for admission are transparent and clear. All applicants are treated according to the same standards and regulations.

According to the university guideline for the recognition of prior learning and credit transfer, students may apply to have classes completed outside of LUT recognized as a substitute for a course at LUT or as part of the minor or elective studies. The decision is made based on the learning outcomes achieved, contents, equivalences and applicability to the degree. The student must apply for the credit transfer in written form and the application can be accepted or accepted on condition, or rejected. If the application is rejected, the reasons for rejection must be stated in the decision. The peers acknowledge that the rules for the recognition of achievements and competences acquired at other higher education institutions are in accordance with the Lisbon Recognition Convention.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 1:

The peers welcome the indication of LUT to revise the learning outcomes of the Bachelor's programme in Energy Technology and the two master's programmes, Energy Technology and Energy Systems to include "engineering design". The peers appreciate that the work will be carried out as part of the next, annual curriculum work. The peers agree that "Engineering design" aspects from the environmental point of view have been included in the curriculum of the Bachelor's programme of Environmental Technology. However, this needs also to be outlined in the learning outcomes. The same applies to the Master's Programme of Sustainable Science and Solutions where design for environmental aspects is focused on LCA (Life Cycle Assessment) education. In summary, the peers confirm their intended requirement that LUT needs to re-write the educational objectives/learning outcomes so that they refer to "engineering design" (engineering processes design).

The peers acknowledge the actions taken by LUT to promote the practical implementation of the Bologna process and appreciate the separate promotion of Bachelor's and Master's degree programmes as well as separate graduation ceremonies. In spite of these measures the peers encourage LUT to continue its efforts to sharpen and separate the Bachelor's from the Master's degree to better align them with the Bologna process.

The peers highly welcome the intention of LUT to reconsider the learning outcomes of the Master's programme in Energy Systems and to rename the program to better correspond to the contents. Until the implementation the peers confirm their intended requirement.

The peers comprehend that the aim of the compulsory internship of 2 ECTS credits is to make students acquainted with the basic rules of working life from the employee's perspective. The peers also understand that the extension of the compulsory internship might lead to unnecessary delays in graduation for some students. However, given that work experiences can be gained in any company not necessarily linked to the profession of the study programme, the peers do not see that the professional practical work-place related experiences are properly developed. In addition, the peers think 4 weeks of internship is too little to develop the professional practical skills appropriately. The peers welcome the planned introduction of a new course on labour market, working life and job search (2 ECTS credits) and recommend to further strengthen the mandatory professional internship and to adjust the credit points accordingly.

2. The degree programme: structures, methods and implementation

Criterion 2.1 Structure and modules

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Study Guides for each degree programme under review
- Curricular overview of all degree programmes, appendices 4-8 of SAR
- 16_Statistics on Student Exchange 2013-2016, appendix to SAR
- Module descriptions: Study guides for all degree programmes include module descriptions

Preliminary assessment and analysis of the peers:

Modularization:

All study programmes under review are modularized. The peers determine that each module is a sum of teaching and learning whose contents are concerted. Most of the modules of the Bachelor's degree programmes encompass between 1 and 5 ECTS credits, whereas most of the modules of the Master programmes are larger in scale, between 3 and 10 ECTS credits. The Bachelor's courses include more in-class teaching than Master courses, which are more based on variable teaching methods and independent studies. The small modules with 1 or 2 ECTS credits in the Bachelor's degree programmes are typically introduction courses, internship courses or compulsory language courses, which are often based on attendance-based learning. LUT explains that this modularisation of small modules in the Bachelor's programmes was chosen due to the request of the students who wanted to have smaller entities of modules and thus smaller and more comprehensive examinations (compare criterion 3 with regard to examination load). In principal, the peers agree that from a formal standpoint this kind of modularisation is possible. Based on the information provided during the discussions with different stakeholder groups, the average study duration for a consecutive Bachelor's and Master's programmes in the engineering field is about 5,7 years; however, the studies can also be completed within 5 years if students were interested as the students explain. The peers did not receive any reliable data on drop-out rates and kindly ask to provide information on this. From the auditors' point of view, the structure of the degree programmes ensures that the qualification level and the intended learning outcomes can be achieved and that the students can complete the degree programmes successfully without any delay.

Practical Approach/Internships

Internships and the practical approach of the degree programmes are being dealt with under criterion 1.1 and 1.3.

Student mobility

LUT explains that there is an introduction of mobility opportunities for all freshmen to give them an opportunity to plan international mobility as early as possible. Furthermore, there are "study abroad counsellors" who can be approached and assist to plan the international mobility in detail; support on an individual level is provided. International mobility is highly promoted and teachers recommend having this international experience. LUT also offers a number of double degree programmes and maintains close linkages to a number of international universities. The students confirm that there are more opportunities to study abroad available than students who are ready to go abroad; students can also receive fi-

nancial support. LUT provides an overview of incoming and outgoing students for the different programmes which shows that active student mobility is taking place, however, differing strongly between the degree programmes. In total about 20% of all LUT students have an international experience. All students who had been abroad are requested to write a report afterwards which can be read by interested students (by country). Engineering students are mostly more reluctant to go abroad but it is gradually improving. The outgoing students sign a learning agreement and usually receive a scholarship if they at least gain 20 ECTS credits, although the aim is to acquire 30 ECTS credits during one semester abroad. The peers conclude that LUT provides good opportunities for international mobility and promotes it accordingly.

Recognition of achievements and competences

The recognition of achievements and competences obtained at another university or outside the tertiary education sector is governed by the "University Regulations". While these specifications are kept rather general, the respective implementation rules ("recognition of prior learning and credit transfer") are fixing a process that is in line with the Lisbon-Convention. In particular, it is laid down that recognition is based on learning outcomes and a rejected recognition has to be justified by the university ("reverse onus-clause"). According to the students, these regulations are put into practice adequately.

Criterion 2.2 Work load and credits

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Study Guides for each degree programme under review
- Module descriptions: Study guides for all degree programmes include module descriptions
- Curricular overview of all degree programmes, appendices 4-8 of SAR

Preliminary assessment and analysis of the peers:

The Bachelor's degree programmes are normally designed for 180 ECTS credit points, whereas the three Master's degree programmes encompass 120 ECTS credit points. When looking at the different curricula overviews the peers note that the workload seems to be distributed very unevenly between the semesters; this applies to Bachelor's as well as to Master's programmes. LUT explains that this is a presentation issue as some courses can be taken during different semesters according to students individual plans, and the credit

points count when the course is completed. The students confirm that based on their experiences the workload is fairly evenly distributed over the semesters. The peers advise to change this workload presentation because in its present state it is misleading.

To measure the amount of work required by students LUT uses the ECTS-System. In section 15 of the "University regulations" it is laid down, that one ECTS-point equals to 26 hours of students' workload including face-to-face teaching hours, individual studying, as well as preparation for and taking the examinations. Within the course-evaluations the allocation of credits to specific modules is checked on a regular basis. The students explain that in some modules like non-technical or business modules credit points can be obtained with less effort than in engineering modules; however, all in all the workload and the corresponding credit points are realistic. The lecturers add that they rather change the teaching mode and adapt the content instead of changing the credit points. The peers understand that the responsible lecturers take measures to adjust the workload if need arises. The average study duration is presented in more detail under criterion 2.1.

In summary, the auditors conclude that there is no structural pressure on the quality of teaching and the level of education due to the workload. The workload seems to be realistic and peaks in the workload are avoided.

Criterion 2.3 Teaching methodology

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Module descriptions: Study guides for all degree programmes include module descriptions

Preliminary assessment and analysis of the peers:
The lecturers of the programmes under scrutiny explain that teaching methods applied in the Bachelor's and Master's programmes in Energy Technology and Environmental Technology include lectures, classroom and laboratory exercises and assignments, project work and seminars. Lectures and exercises are the most common teaching methods, but in many courses, there is more variety and students play a more active role. The peers welcome the very distinguished description of the applied teaching methodology in the module descriptions. According to the peers, these descriptions demonstrate clearly that the teaching methodology is planned according to the learning outcomes of a module; the peers learn

that the teaching methodology is based on a so called "student-oriented approach". The peers note an adequate balance between attendance-based learning and self-study. As outlined under criterion 1.3 the peers also appreciate the team and group work examples which show that a number of non-technical social skills are being trained in the programmes. The students are familiarised with independent academic research in the final Bachelor's or Master's Thesis (compare criterion 3 for more details). In summary, the peers judge the teaching methods and instruments to be suitable to support the students in achieving the learning outcomes.

Criterion 2.4 Support and assistance

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- LUT general Information: http://www.lut.fi/web/en/get-to-know-us;jsessionid=2EA08C15B5B663BD5E784FCF2FDDAF39.wwwlut2, 10.04.2017.
- LUT UNI-Portal: https://uni.lut.fi/en/web/lut.fi-eng/home, 10.04.2017.

Preliminary assessment and analysis of the peers:
The peers examine the general information about LUT on the website as well as the course related websites; the UNI portal provides general information concerning studies at LUT and specific information regarding the degree programmes. The peers agree that a lot of general information about the different degree programmes is available; information about the Finnish programmes is only available in Finnish. The peers think that this is plausible as students who want to study theses programmes need to have a good command of Finnish. Interested stakeholders are able to obtain information about different administrative processes as well as about the programmes themselves. However, some international students would have appreciated to find more detailed information about the degree programmes on the subject-specific website. The study guide, for example, is on the UNI-Portal, however, this is not clearly indicated on the subject-specific website and was not evident for the international students; they are also lacking straight forward contact details to be able to address competent persons for content-related questions. The peers strongly advise the responsible programme coordinators to provide more information on the subject specific websites (compare also criterion 5).

Apart from this, LUT provides support and assistance throughout the life-cycle of a student. Each student at LUT has an electronic personal study plan (PSP) that is based on the degree structure described in the study guide. The first version of the PSP is designed in accordance with the study counsellor at the beginning of the studies and is updated regularly. Specially educated students act as "peer-tutors" and help freshmen throughout the acclimatization period at LUT. Even for the further study progress the peer-to-peer principle plays an important role in LUTs support system: For example, advanced Students provide as so called "Study-Advisors" fellow students with guidance even in later stages of their education. So called "Study counsellors" are providing in-depth guidance in preparing the personal study plans. "Teacher Tutors" help students for example in the selection of elective course and minor subjects. Problems related to specific courses/modules can be addressed to the competent lecturers at any time. The students emphasise that they are highly satisfied with the support measures at LUT and that they appreciate the "open door" policy of the staff members. There are conflict solution processes in place if there are disagreements (compare criterion 6). The auditors conclude that LUT makes adequate resources available to provide individual assistance, advice and support for all students. The peers highlight that the allocated advice and guidance, namely the tutors and advisors, assist the students in achieving the learning outcomes and in completing the course within the scheduled time.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 2:

The peers thank for the additional information on the drop-out rates for students from the Energy Technology and Environmental Engineering programmes. The peers acknowledge the fairly moderate drop-out rates which indicate that the degree programmes can successfully be studied in the given timeframe. The peers also appreciate that the presentation of the workload allocation in the Curriculum Tool will be modified.

3. Exams: System, concept and organisation

Criterion 3 Exams: System, concept and organisation

Evidence:

- University regulations on education and the completion of studies, approved on 22 June 2016
- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology

- Module descriptions: Study guides for all degree programmes include module descriptions
- Written examinations and/or if applicable Information on case-/project-/study-works in “Moodle”
- Inspection of Bachelor- and Master-Theses on 6 April 2017
- LUT “General Instructions On Writing A Bachelor´s Thesis/Computer Science”
- LUT “Degree Program in Industrial Engineering and Management. Bachelor Thesis and Seminar” (in Finnish only)

Preliminary assessment and analysis of the peers:

Examination organisation

Examination and teaching periods are published in the academic calendar as well as the examination schedule and instructions concerning examinations. Examinations can be arranged during the teaching periods or during the examination weeks. There are altogether eight examination weeks during the academic year, and an additional exam week for retakes in summer. The peers also welcome the so-called “electronic exam tool” and the new electronic exam hall which provides the possibility for LUT students to take exams more flexibly. The lecturers explain that they upload the examination to the system and the student can freely choose when to take the exam. Some courses of the degree programmes in Energy Technology and Environmental Technology have applied this possibility with good results as students and lecturers confirm. Students can retake exams normally up to three times; after having failed three times they may apply for an additional retake form the teacher responsible for the course. The students confirm that the examination schedule is usually well balanced and allows enough time for preparation.

Examination methods

Based on the module descriptions the peers can see that the form of examination is communicated clearly including the weighing factor if several assignments apply. Examinations are mostly written examinations, the standard duration is three hours. Other types of student performance assessment, such as reports, essays, presentations, case assignments, learning diaries, and laboratory assignments are widely used in the degree programmes. Although oral examinations are an exception the peers still gain the impression that students develop oral skills appropriately as they have to give a number of oral presentations in projects and group work and also have to provide feedback to their peers; during the interview round with the students the peers gain a positive impression of the oral skills of the students. The peers conclude that the examinations are structured in a way to cover all

of the intended learning outcomes (knowledge, skills and competences) and provide students continuous feedback on their progress in developing competences. The peers analyzed a number of provided examinations and confirm that they are of adequate standard at the level aimed at.

The rules for re-sits, disability compensation, illness and other circumstances are defined in the University regulations on education and the completion of studies and therefore transparent to all stakeholders.

Final Thesis

An independent research project carried out for the Bachelor's Thesis (10 ECTS credit points) or Master's Thesis (30 ECTS credit points) constitutes a part of every programme. The *Bachelor's Thesis* is completed as a course included in the student's intermediate specialisation studies. The topics of the thesis typically deal with a variety of problems associated with the research and education in the competence area. The supervisor of the thesis is typically a researcher of the competence area. The Bachelor's Thesis seminar course (2 ECTS credit points) with an online learning platform (Moodle) is used to support the thesis process. Topic suggestions mostly come from the staff of the competence area, but it is also possible that a student suggest a topic to a professor who then makes the decision if the topic is suitable for the Bachelor's Thesis or not. During the discussion with the programme coordinators the peers understand that most Bachelors' Theses deal with literature surveys and background descriptions in the context of research projects at LUT; only very few theses are written in the industry. Given the recommendation that Bachelor's graduates shall be better prepared for the labour market and comply with the Bologna process in terms of employability the peers are of the opinion that it would be worthwhile to write more Bachelors' Theses in industry as a gateway to later employment. The programme coordinators point out that the majority of Bachelors' Theses is not considered to be substantial enough to be written in industry. Industrial partners normally expect more time to produce a substantial piece of work; the dedicated 10 ECTS credit points are considered to be too little input. The peers comprehend the issue but recommend to alternatively award more credit points to the theses to give students an opportunity to dedicate more time and efforts to their work which makes it more attractive for business partners to support Bachelors' Theses. This would also contribute to improving the employability of Bachelor's graduates and comply with the Bologna process. The Bachelor's Theses examined by the peers are considered to be of acceptable quality.

The *Master's Thesis* is part of specialisation studies in the Master's programme. The Master's Thesis is typically accomplished as a research or development project in co-operation with an industry partner. The Master Thesis project normally requires six months of full-

time work. The topic of the Master's Thesis is agreed on between the supervising professor, who is also the first examiner of the thesis, the student, and the possible industrial partner. The instructions published in the UNI portal for preparing a Master's Thesis give detailed guidelines on the prerequisites for the approval of a thesis topic. However, international students complain that for them it is comparatively challenging to find business partners for the final thesis due to language barriers. International students enrolled in Master's programmes normally do not speak Finnish at a level to work in a Finnish company. Although the peers are of the opinion that Master's students should be able to take the initiative and approach relevant businesses on their own, they comprehend that the language barrier makes it particularly difficult for them. Therefore they recommend improving the support for international students to find topics for their Master's Thesis.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 3:

The peers acknowledge the information that LUT is aware of the challenge to get Master's Thesis places for non-Finnish speaking students from Finnish companies. In the degree programme in Environmental Technology students are invited to Master's Thesis info annually in November; a similar practice shall be reinstated for Energy Technology. The peers welcome this intention and stick to their recommendation to improve the support for international students to find topics for their Master's thesis. Furthermore, the peers also confirm their recommendation to enhance the substantiality of the Bachelor's theses to write them in industry.

4. Resources

Criterion 4.1 Staff

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Staff Handbook: 14_Staff Handbook_ClusterC
- Staff members on LUT website: http://research.lut.fi/converis/portal/list?show=Person&filter=&searchkey=&sortBy=cffamilynames&sortOrder=true&cypher=All&page=1&items=10&showAll=Person&treeView=false&auxfun=&moreOrLess=&lang=en_GB, 10.04.2017.

Preliminary assessment and analysis of the peers:
The peers understand the general organisation of staff at LUT in the following manner. The composition of teaching and research personnel at LUT is based on a tenure track system. The members of the teaching staff are either employed in a tenure track position or a non-tenure track position. The aim of the tenure track positions is to advance to the level of full professor based on post-doctoral achievements and qualifications. Non-tenure track positions are either research or teaching oriented, based on the needs of the School of Engineering. The peers find out that the professors and assistant professors hold permanent positions, whereas the post-doctoral fellows and PhD-students are employed on four year contracts. The permanent staff members have all different contracts with respect to the teaching load, time for research and administrative tasks. Most members of the academic staff have both teaching and research activities. LUT provides a staff handbook for all degree programmes; this is highly welcomed by peers even though the provided list of staff members and the links to the respective website do not work. But on the LUT website the staff members and the individual descriptions can be found and provide a proper picture of the qualification profiles. The peers analyze the staff handbook and the referenced websites and conclude that the composition, scientific orientation and qualification of the teaching staff team are suitable for successfully implementing the degree programmes. Based on the information provided in the self-assessment report, the peers are convinced that the number of staff members is sufficient to successfully implement the programmes under review.

LUT puts a strong emphasis on research activities and focuses on the different aspects of energy and environmental topics as outlined in detail in the self-assessment report. The research activities typically include working on research projects, reporting and publishing research results and supervising final theses.

Criterion 4.2 Staff development

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology

Preliminary assessment and analysis of the peers:
To improve the quality of teaching, LUT has published the LUT Teacher's Quality Manual electronically on the LUT intranet to support teaching. It contains information and instructions on the planning and implementation of courses. The university also offers pedagogical

training for the teaching personnel to improve the teaching skills of teachers. The attendance of these courses is highly recommended and has also an impact on the salary as the lecturers confirm. Most teachers indicate that they have participated in some didactical training; support is also provided on the individual course level and teachers can obtain assistance to didactically improve their lectures and courses. The peers conclude that the teachers are being offered support mechanisms to further develop their professional and teaching skills and that these offers are also used actively by most staff members.

Criterion 4.3 Funds and equipment

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- On-site visit of laboratories

Preliminary assessment and analysis of the peers:
The peers learn that LUT School of Energy Systems receives about 60% of its financial resources from the Finnish Ministry of Education and Culture. About 40% of the budget comes from sources other than the university like from the Finnish Funding Agency for Innovation (TEKES), private companies, the Academy of Finland and the European Union. The external funding is primarily connected with different research projects and highly competitive but not essential for financing the teaching staff. The peers analyze the information provided in the self-assessment report and come to the conviction that the financial means are sufficient and secured for the timeframe of the accreditation.

The learning facilities and the teaching equipment are described in detail in the self-assessment report. During the on-site visit the peers took a tour over the campus to get a first-hand impression of the availability and the condition of the equipment. In the LUT library the students have access to electronic scientific and educational resources and to the electronic library system, including current publications that are needed for study and research. The students also confirm that the learning facilities are sufficient in quantity and almost permanently available. They express their general satisfaction with the available resources, the technical equipment, the laboratories, and the library. LUT maintains a number of computer rooms and available computers with standard software can be found at any time. However, when it comes to very specialized software in energy or environmental engineering, there are considerable bottlenecks with regard to the number of available software licenses; the example was given that about 20 students have to share 6 licenses of specific

software applications which leads to considerable challenges at peak times when all students are supposed to work with the software. It turned out that group work of three students working with one computer at the same time is fairly ineffective. The peers think that this situation needs to be improved and recommend providing sufficient access to specialized software applications to ascertain that all students are capable to get a good command of the respective software. The laboratory work is primarily carried out in the Department of Electrical Engineering and the Department of Chemistry. The peers notice that the breadth of the hands on experiments done in the laboratories is focused on mechanical separation processes whereas other important techniques like distillery and thermal processes are only underpinned with very little laboratory experiments. The equipment for environmental engineering is particularly limited as the peers point out. The so-called "sauna-experiment" is an exercise to learn the measurement of emissions, which is positively acknowledged by the peers; however, in the first accreditation it had been recommended by the peers to offer better possibilities to the students to acquire skills and competencies in laboratories. Even though they note that efforts have been taken to improve the situation, the peers think that a broader variety of experiments and a higher amount of experimental laboratory places would be required to fully achieve the intended learning outcomes. Students and teachers explain that at times the laboratories are heavily used but due to good organization it was possible to carry out basic laboratories for all students. The peers are still of the opinion that for practical hands-on competences the variety and the quantity of laboratory places needs to be increased. Therefore the peers conclude that it would be useful to equip the laboratories better and to include more corresponding experiments in the practical work.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 4:

The peers agree with LUT that bottlenecks of very specialized software application most likely arise during few weeks a year and increasing the amount of licenses would lead to increasing costs and reduced utilisation rate. Therefore, the peers welcome the different measures LUT proposes to accommodate the needs of the students and stick to their recommendation that LUT should to provide sufficient access to specialized software applications.

The peers take note of the explanation of LUT that neither the students nor their employers have brought out any deficiencies in the skills of the graduated students. However, the peers are still convinced that laboratory experiments in field of distillery and thermal processes are very little and therefore they recommend to offer better possibilities to the students to acquire skills and competencies in laboratories.

5. Transparency and documentation

Criterion 5.1 Module descriptions

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Module descriptions: Study guides for all degree programmes include module descriptions, Appendices 9-13 to the self-assessment report
- List of all degree programmes under accreditation: http://www.lut.fi/web/en/school-of-energy-systems/studies (10.04.2017)
- Website for Ma Energy systems: http://www.lut.fi/web/en/admissions/masters-studies/msc-in-technology/energy-technology/energy-systems (10.04.2017)
- Website for Ma Sustainability Science and Solution: http://www.lut.fi/web/en/admissions/masters-studies/msc-in-technology/environmental-engineering/sustainability-science-and-solutions (10.04.2017)

Preliminary assessment and analysis of the peers:
The peers positively note that the full set of modules descriptions is included in the so-called study guides which are attached to the self-assessment report; the study guides are published on the website of LUT but not clearly linked to the subject-specific website which makes it difficult to identify them. The peers strongly advise to make the study guides more visible on the subject specific websites.

The peers examine the module descriptions of all five programmes and note that the modules have comprehensible names and identification codes. The peers also acknowledge that the responsible module coordinators as well as the lecturers are mentioned throughout all module descriptions. Requirements for the successful participation in a module are not mentioned which would be worthwhile to add as the peers advise. The work load is properly specified in the teaching methods and explained in detail which activity requires which kind of workload. In most cases the total workload corresponds with the number of credit points awarded to the module; however, in some cases the calculation is wrong like in modules Fundamentals of Engineering Thermodynamics, Basics of Electric Engineering, and Functions, Linear Algebra and Vectors and others. The peers advise to check all work load-credit point calculations. The intended learning outcomes are mostly referring to different levels of competence (knowledge, skills, competence) which is positively judged by the peers. In addition, the content of the modules is explained in detail. As indicated under

criterion 2.3 the peers welcome the very detailed and informative section on the teaching methodology and think that this description explains understandably how the intended learning outcomes are supposed to be achieved. The type of examination and the calculation of the overall module mark are outlined. The reading list is called prerequisites and explains which literature is supposed to be known when attending the course. The peers think that the very limited reference to literature is helpful for the students as it might be motivational to really get acquainted to the recommended literature. In summary, the peers conclude that the module descriptions have considerably improved since the first accreditation and think that the recommendation regarding the improvement of the module descriptions has been fulfilled. However, some minor corrections, as outlined in the previous section, are still advised.

Criterion 5.2 Diploma and Diploma Supplement

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Exemplary Diploma Supplements
- Exemplary Transcripts of Records

Preliminary assessment and analysis of the peers:
Section 23 of the "University regulations" LUT states that an English Diploma Supplement is issued automatically and free of charge along with the degree certificate and a transcript of records. Sample Copies of the Degree Certificates are not available and should be handed in later for each degree programme under review.

Together with the self-assessment report LUT provides for each programme under review specific example copies of the Diploma Supplement. The peers take note that the documents neither contain information about the overall objectives of the respective degree programmes nor the courses completed or the individual results. Statistical data for a categorization of individual results are not presented either. Insofar the auditors point out that the Diploma Supplement needs to contain detailed information about the educational objectives, intended learning outcomes and the individual performance of the student. Moreover, statistical data according to the ECTS-Users' guide in addition to the final grade needs to be provided. This had been recommended in the first accreditation already but had not been fulfilled as the peers state.

Criterion 5.3 Relevant rules

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- Module descriptions: Study guides for all degree programmes include module descriptions, Appendices 9-13 to the self-assessment report
- List of all degree programmes under accreditation: http://www.lut.fi/web/en/school-of-energy-systems/studies, 10.04.2017
- Ma Sustainability Science and Solutions: http://www.lut.fi/web/en/admissions/masters-studies/msc-in-technology/environmental-engineering/sustainability-science-and-solutions, 12.04.2017
- University Regulations on Education and the Completion of Studies. Approved on 22 June 2016: https://uni.lut.fi/en/c/document_library/get_file?uuid=5f89517f-8e4c-4b34-9b9d-45c2b7e7f8be&groupId=10304, 12.04.2017
- LUT UNI-Portal: Instructions and Regulations (https://uni.lut.fi/en/web/lut.fi-eng/instructions-and-regulations, 12.04.2017
- LUT UNI-Portal: Study-Guides (https://uni.lut.fi/en/web/lut.fi-eng/study-guides9, 12.04.2017
- LUT UNI-Portal: Opinto-Oppaat, https://uni.lut.fi/opinto-oppaat1, 15.04.2017

Preliminary assessment and analysis of the peers:

The auditors learn that the rights and duties of the university are defined in the Universities Act, Regulations of LUT and the LUT Code of Conduct. This document provides a general framework on admission procedures, aims and structure of Bachelor- and Master-Programmes, the organisation of examination and other administrational issues. These regulations are refined in more detail on the level of the different "schools" according to the specific programme requirements. In addition, LUT has published several guidelines or instructions for given target groups more precisely (e.g. Personnel guide for new employees, LUT Teacher's Quality Manual, Quality guide for studying and learning at LUT for students, Ethical guidelines for academic studies, Guidebook for students in LUT's decision- making bodies). All of the information needed in daily work and studies is published on the LUT intranet for personnel and in the UNI portal for students. The peers conclude that all relevant information is available for interested stakeholders.

The peers understand that study regulations on programme-level are unknown in Finland. Instead, the academic board defines "study guides" that contain information about learning objectives and the courses offered. Individual study plans are prepared for each student for the entire education. The students confirm that this kind of individual support is appreciated and helps to pursue an individual study path. Information about the overall objectives and learning outcomes are published on the subject-specific website of LUT. The study guides are published on the UNI-Portal and not directly on the subject specific website. As indicated under criterion 2.4, although all programme related information is available on the website the information is scattered at different places; especially international students complained that they had not been able to identify all information needed. That is why the peers recommend making all subject-related information available at one subject-specific website.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 5:

The peers gratefully received the additional certificates and Transcripts of Records of the degree programmes. The peers welcome that the educational objectives and intended learning outcomes of the programmes will be included to the Diploma Supplements beginning from the Academic Year 2017-18. Until its implementation, the peers confirm their intended requirement. The peers appreciate that LUT wants to thoroughly review the contents of the subject-specific/degree programme parts of the UNI-portal in order to better serve the students. The peers stick to their intended recommendation to make all subject-related information available on the subject-specific website.

6. Quality management: quality assessment and development

Criterion 6 Quality management: quality assessment and development

Evidence:

- Self-Assessment Report 2017: Bachelor's and Master's Programmes in Energy Technology and Environmental Technology, Lappeenranta University of Technology
- LUT, Quality Manual Version 5.0: http://www.lut.fi/documents/27578/78601/lut-quality-manual.pdf, 12.04.2017
- 15_Performance of programmes 2014-2016_EneEnvTech, Appendix to SAR

- 17a_Feedback by the commissioner of final thesis 2015_LUT, Appendix to SAR
- 18_LUTCourse feedback questionnaire, Appendix to SAR

Preliminary assessment and analysis of the peers:
The peers can see that the LUT Quality Manual, which is publicly available on the university website, concisely outlines the quality management system of the university. The peers can see that the quality management system is closely connected to the university's strategic and operations management as had been illustrated during the discussions with the LUT management. As such, quality management is part of the university's normal operation with the underlying idea of continuous improvement as the peers comprehend. LUT maintains external as well as a number of internal quality assurance procedures.

Course feedback is collected in each course in web surveys delivered by the student guild. Standard questions for all courses concern e.g. the learning experience, the student's own performance, the suitability of teaching methods, and the general impression about the course. In addition, teachers are able to add their own questions to the questionnaires. Between 25-40% tend to give feedback as the lecturers report; in most cases, feedback is only provided if something goes wrong in a course as the students admit. A questionnaire is part of the appendices to the self-assessment report. Course-specific evaluations are delivered to the teachers responsible for the courses. The results are also forwarded to the heads of the degree programmes and the vice rector for education once a semester. If an individual course receives a low average score, the reasons will be examined. In the degree programmes the course feedback results are discussed twice a year in an open session by the students and faculty. The students report that they can see that criticisms and recommendations are taken up. One student reported an incident where he disagreed with a lecturer and addressed the issue directly and both of them could find a common understanding how to proceed. Students mention also a "grey list" where students have the possibility to indicate critical issues anonymously. Once the students were dissatisfied with the grading of an examination and reported this to the "grey list". This led to a revision of the grading results of the examination of another teacher who confirmed that the grading had been fair. The students reported another case where the rules for the implementation of a project had been unclear; the students complained that they were unable to follow the given guidelines and thereafter the guidelines were redefined to make them understandable for the students. The students praise a very open and cooperative relationship with the teachers. The peers conclude that the feedback loop for course evaluations is closed and that LUT uses the feedback in a constructive way to improve the quality of the courses. As outlined under criterion 1.1 there are close linkages between LUT and business partners and alumni which provide their feedback on the quality of the degree programmes. Also other indicators, like the amount of applicants, graduate feedback and employment of

graduates are monitored systematically as the peers can see from the provided documentation.

In summary, the peers come to the conviction that LUT maintains a very sophisticated quality assurance system with Key Performance Indicators on the management level, a number of quality assurance procedures covering different stakeholders groups and have feedback mechanisms in place to improve the quality of its procedures and programmes. To even further develop the good quality assurance system the peers encourage LUT to also develop a set of Key Performance Indicators to measure and track the effectiveness of the quality management system.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 6:

The peers confirm their recommendation to develop a set of Key Performance Indicators to measure and track the effectiveness of the quality management system.

D Additional Documents

Before preparing their final assessment, the panel ask that the following missing or unclear information be provided together with the comment of the Higher Education Institution on the previous chapters of this report:

1. Transcript of Records, certificates for all degree programmes
2. Statistical data on drop outs

E Summary of the peers

The peers summarize their analysis and final assessment for the award of the seals as follows:

Degree Programme	ASIIN-seal	Subject-specific label	Maximum duration of accreditaiton
Ba Environmental Technology	With requirements for 1 year	EUR-ACE	30.09.2023
Ma Sustainability Science and Solutions	With requirements for 1 year	EUR-ACE	30.09.2023
Ba Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2023
Ma Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2023
Ma Energy Systems	With requirements for 1 year	EUR-ACE	30.09.2022

Requirements and recommendations for the applied labels

Requirements

For all degree programmes

A 1. (ASIIN 1.1) Re-write the educational objectives/learning outcomes so that they refer to engineering design (engineering processes design).

A 2. (ASIIN 5.2) Ensure that the Diploma Supplement contains detailed information about the educational objectives and intended learning outcomes. Provide also statistical data according to the ECTS-Users‘ guide in addition to the final grade.

For the Master’s degree programme Energy Systems

A 3. (ASIIN 1.2) Ensure that the name of the degree programme, its intended learning outcomes, and its content correspond with each other.

Recommendations

For all degree programmes

E 1. E 1. (ASIIN 1.3) It is recommended to strengthen the mandatory professional internship and to adjust the credit points accordingly.

E 2. (ASIIN 4.3) It is recommended to provide sufficient access to specialized software applications.

E 3. (ASIIN 5.3) It is recommended making all subject-related information available on the subject-specific website.

E 4. (ASIIN 6) It is recommended to develop a set of Key Performance Indicators to measure and track the effectiveness of the quality management system.

For the Bachelor's degree programmes

E 5. (ASIIN 1.1) It is recommended sharpening and separating the Bachelor's from the Master's degree to better align them with the Bologna process.

E 6. (ASIIN 3) It is recommended to enhance the substantiality of the Bachelor's theses to write them also in industry.

E 7. Proposal of the ASIIN TC 01: It is recommended to strengthen the bachelor as the first professional degree in line with the Bologna process. Consequently, it is recommended to prolong the duration and enhance the substantiality of the bachelor theses to improve the employability.

E 8. (ASIIN 4.3) It is recommended to offer better possibilities to the students to acquire skills and competencies in laboratories.

For the Master's degree programmes

E 9. (ASIIN 3) It is recommended to improve the support for international students to find suitable topics for their Master's thesis.

F Comment of the Technical Committees

Technical Committee 01 (19.06.2017)

Assessment and analysis for the award of the ASIIN seal:

The Technical Committee intends to align the recommendations and requirements of the different clusters and thus suggests to change recommendation 3, dealing with the publication of programme relevant information on the website, to the same requirement as used in Cluster D. Furthermore, TC 01 changes recommendation to the same like in Cluster D. Regarding recommendation 4 which demands key performance indicators to measure the effectiveness of the quality management system, the Technical Committee concludes that this recommendation would mean unequal treatment if compared with other procedures and should be discarded. Finally, the Technical Committee underlines that recommendation 5 and 6 should be merged to a more general recommendation dealing with strengthening the bachelor as the first professional degree in line with the Bologna process and prolonging the duration and enhancing the substantiality of the bachelor theses to improve the employability. Apart from this, the Technical Committee fully supports the requirements and recommendations as suggested by the peers.

Assessment and analysis for the award of the EUR-ACE® Label:

The Technical Committee judges that the intended learning outcomes of the degree programme(s) do [not] comply with the engineering specific part of Subject-Specific Criteria of the Technical Committees 01 and 02.

The Technical Committee 01 - Mechanical Engineering/Process Engineering recommends the award of the seals as follows:

Degree Programme	**ASIIN-seal**	**Subject-specific label**	**Maximum duration of accreditaiton**
Ba Environmental Technology	With requirements for 1 year	EUR-ACE	30.09.2023
Ma Sustainability Science and Solutions	With requirements for 1 year	EUR-ACE	30.09.2023
Ba Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2023
Ma Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2023
Ma Energy Systems	With requirements for 1 year	EUR-ACE	30.09.2022

Requirements and recommendations for the applied labels

Requirements

For all degree programmes

A 3. (ASIIN 5.3) TC 01 suggests changing recommendation 3 to the same requirement as used in Cluster D; TC 02 agrees: Provide access to all relevant documents for all stakeholders.

Recommendations

For all degree programmes

E 1. E 1. (ASIIN 1.3) TC 01 changes this recommendation to the same like in cluster D, TC 02 agrees: ~~It is recommended to strengthen the mandatory professional internship and to adjust the credit points accordingly.~~ It is recommended to extend the ~~length~~ duration of the compulsory internship and to demand a connection with the field of studies.

E 2. (ASIIN 5.3) TC 01 changes this recommendation to a requirement; TC 02 agrees: ~~It is recommended making all subject-related information available on the subject-specific website.~~

E 3. (ASIIN 6) TC 01 thinks that this recommendation is unfair compared with other procedures and suggests removing this recommendation: ~~It is recommended to develop a set of Key Performance Indicators to measure and track the effectiveness of the quality management system.~~

For the Bachelor's degree programmes

~~E 4. (ASIIN 1.1) It is recommended sharpening and separating the Bachelor's from the Master's degree to better align them with the Bologna process.~~

~~E 5. (ASIIN 3) It is recommended to enhance the substantiality of the Bachelor's theses to write them also in industry.~~

E 6. Proposal of the ASIIN TC 01: It is recommended to strengthen the bachelor as the first professional degree in line with the Bologna process. Consequently, it is recommended to prolong the duration and enhance the substantiality of the bachelor theses to improve the employability.

Technical Committee 02 (20.06.2017)

Assessment and analysis for the award of the ASIIN seal:
In an attempt to come to consistent conclusions with regard to essentially identical deficiencies in all clusters at LUT, the Technical Committee follows the suggestions of the responsible Technical Committee 01 for the most part.

Thus, it recommends changing recommendation 3 to an additional requirement 3 considered necessary also in Cluster D.

Furthermore, the Technical Committee changes the recommendation 1 to the same like in Clusters A and D, and, in addition to that, proposes a minor editorial modification substituting the term “length” by the word “duration”.

Although the audit report does not substantiate in detail the peers’ suggestion to develop an array of key performance indications in order to enable the School of Energy Systems to more closely monitor the effectiveness of the quality management system in place, the Technical Committee concludes from the data base regarding the academic achievements at hand in the School (see Cluster A), that there is considerable room for improvement. However, the peers’ overall positive assessment of the quality assurance system seems hardly justifying a requirement to that end like in Cluster A. Nonetheless, a recommendation would at least indicate that the School should envisage further steps in developing a meaningful data base for an effective evaluation of its quality assurance measures. Consequently, TC 02 proposes to maintain the respective recommendation 3.

TC 02 follows TC 01 in combining the former recommendations 5 and 6 concerning the consolidation of the Bachelor’s degree programmes in general and the Bachelor thesis in particular to a new recommendation 4.

Assessment and analysis for the award of the EUR-ACE® Label:
The Technical Committee judges that the intended learning outcomes of the degree programmes do comply with the engineering specific part of Subject-Specific Criteria of the Technical Committee 02.

The Technical Committee 02 - Electrical Engineering/Information Technology recommends the award of the seals as follows:

Degree Programme	**ASIIN-seal**	**Subject-specific label**	**Maximum duration of accreditaiton**
Ba Environmental Technology	With requirements for 1 year	EUR-ACE	30.09.2024
Ma Sustainability Science and Solutions	With requirements for 1 year	EUR-ACE	30.09.2024
Ba Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2024
Ma Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2024
Ma Energy Systems	With requirements for 1 year	EUR-ACE	30.09.2022

Technical Committee 06 (13.06.2017)

Assessment:

The technical committee discusses the procedure. It follows the proposal of decision in all aspects concerning the Bachelor Enviromental Technology and the Master Programms Sustainability Science and Solutions and Energy Systems unchanged.

Assessment and analysis for the award of the EUR-ACE® Label:

The Technical Committee judges that the intended learning outcomes of the degree programmes do comply with the engineering specific part of Subject-Specific Criteria of the Technical Committees 01 – Mechanical Engineering and 06 – Industrial Engineering.

The Technical Committee 06 - Industrial Engineering recommends the award of the seals as follows:

Degree Programme	**ASIIN-seal**	**Subject-specific label**	**Maximum duration of accreditaiton**
Ba Environmental Technology	With requirements for 1 year	EUR-ACE	30.09.2024
Ma Sustainability Science and Solutions	With requirements for 1 year	EUR-ACE	30.09.2024
Ba Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2024
Ma Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2024
Ma Energy Systems	With requirements for 1 year	EUR-ACE	30.09.2022

G Decision of the Accreditation Commission (30.06.2017)

Assessment and analysis for the award of the subject-specific ASIIN seal:

The Accreditation Commission discusses the procedure and agrees with the proposal of the Technical Committees 01 and 02 to change the original recommendation regarding the accessibility of programme specific information on the website of LUT to a requirement to harmonize it with the decisions of other LUT accreditation clusters. Likewise, the Accreditation Commission decides to add requirement 3 which asks LUT to provide a concept for a systemic monitoring of the study progress and its intended use for the development of the degree programmes. The Accreditation Commission also agrees to the suggested changes of recommendation 1 to extend the duration of the compulsory internship and to add recommendation 7 to this recommendation which wants to strengthen the bachelor as the first professional degree in line with the Bologna process. Regarding recommendation 4 which demands key performance indicators to measure the effectiveness of the quality management system, the Accreditation Commission concludes that this recommendation would mean unequal treatment if compared with other procedures and has to be discarded. Finally, the Commission thinks that the recommendations 5 and 6 should be merged to one recommendation which is attached to recommendation 1 now. Apart from this, the Accreditation Commission confirms the requirements and recommendations as suggested by the peers and Technical Committees.

Assessment and analysis for the award of the EUR-ACE® Label:

The Accreditation Commission deems that the intended learning outcomes of the degree programme(s) do comply with the engineering specific parts of Subject-Specific Criteria of the Technical Committees 01, 02, and 06.

The Technical Committee 01 - Mechanical Engineering/Process Engineering recommends the award of the seals as follows:

Degree Programme	**ASIIN-seal**	**Subject-specific label**	**Maximum duration of accreditaiton**
Ba Environmental Technology	With requirements for 1 year	EUR-ACE	30.09.2024
Ma Sustainability Science and Solutions	With requirements for 1 year	EUR-ACE	30.09.2024
Ba Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2024
Ma Energy Technology	With requirements for 1 year	EUR-ACE	30.09.2024
Ma Energy Systems	With requirements for 1 year	EUR-ACE	30.09.2022

Requirements

For all degree programmes

A 1. (ASIIN 1.1) Re-write the educational objectives/learning outcomes so that they refer to engineering design (engineering processes design).

A 2. (ASIIN 5.2) Ensure that the Diploma Supplement contains detailed information about the educational objectives and intended learning outcomes. Provide also statistical data according to the ECTS-Users‘ guide in addition to the final grade.

A 3. (ASIIN 5.3) Provide access to all relevant documents for all stakeholders.

A 4. (ASIIN 6) Provide a concept for a systemic monitoring of the study progress and its intended use for the development of the degree programmes. This should include meaningful cohort-wise statistical data concerning the graduation rate, the drop-out rate, the examination failure rate and the duration of study. Prove evidence that first steps of its implementation have been taken.

For the Master’s degree programme Energy Systems

A 5. (ASIIN 1.2) Ensure that the name of the degree programme, its intended learning outcomes, and its content correspond with each other.

Recommendations

For all degree programmes

E 1. (ASIIN 1.3) It is recommended to extend the duration of the compulsory internship and to demand a connection with the field of studies in order to strengthen the bachelor as the first professional degree in line with the Bologna process and adapt the wording of the learning outcomes accordingly.

E 2. (ASIIN 4.3) It is recommended to provide sufficient access to specialized software applications.

For the Bachelor's degree programmes

E 3. (ASIIN 1.3) It is recommended to prolong the duration and enhance the substantiality of the bachelor theses to improve the employability.

E 4. (ASIIN 4.3) It is recommended to offer better possibilities to the students to acquire skills and competencies in laboratories.

For the Master's degree programme Energy Systems

E 5. (ASIIN 3) It is recommended to improve the support for international students to find suitable topics for their Master's thesis.

H Fulfilment of Requirements (29.06.2018)

Decision of the Accreditation Commission (29.06.2018)

The Accreditation Commission decides to prolong the award of the seals as follows:

Degree Programme	**ASIIN-seal**	**Subject-specific label**	**Maximum duration of accreditaiton**
Ba Environmental Technology	All requirements fulfilled	EUR-ACE	30.09.2024
Ma Sustainability Science and Solutions	All requirements fulfilled	EUR-ACE	30.09.2024
Ba Energy Technology	All requirements fulfilled	EUR-ACE	30.09.2024
Ma Energy Technology	All requirements fulfilled*	EUR-ACE	30.09.2024
Ma Energy Systems	All requirements fulfilled*	EUR-ACE	30.09.2022

The Accreditation Committee for Degree Programmes decides to include the following reference into the notifying letter to the HEI:

"The HEI shall be advised that the naming of the Energy related Master programmes and its consistency with the intended study objectives and curricula will be thoroughly assessed in the course of the reaccreditation procedure."

Appendix: Programme Learning Outcomes and Curricula

According to the self assessment report the following **objectives** and **learning outcomes (intended qualifications profile)** shall be achieved by the Bachelor's degree programme Ba Energy Technology:

In this BSc programme, students develop knowledge, skill and competences in energy production, transmission, distribution and use. They familiarise themselves with a variety of plants and will learn to understand the principles of energy production. The studies are a combination of technology and natural sciences – mathematics, physics and chemistry. Students will learn about basic methods of energy production, such as solar, wind, steam and nuclear power engineering, as well as their operation and security. They will learn to understand and manage a variety of energy production technologies and evaluate how energy affects the environment, the economy and the society. After completing the degree, students can continue studies in MSc programmes.

After completing the Bachelor's programme, students will be able to

- describe the basic physical phenomena related to energy technology Bachelor's and Master's programmes in Energy Technology and Environmental Technology
- apply basic equations of thermal engineering in the examination of energy conversion related processes
- describe the structure and operation principles of the equipment related to energy technology (boilers, turbines, compressors, fans, heat exchangers)
- calculate operating values of equipment and define their measurement principles
- describe the operation principles of various energy conversion processes
- compare the applicability of various energy conversion processes to different applications from technological, economic and environmental perspectives
- acquire information from various sources and evaluate their quality and reliability
- communicate both orally and in writing in the national and international context
- work in projects as a specialist in energy technology.

The following **curriculum** is presented:

1. Academic year Compulsory courses in BSc in Energy Technology	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
	BH50A0001 Energiatekniikan peruskurssi/Introduction to Energy Technology	2	BH60A0000 Ympäristötekniikan perusteet/Basic Course in Environmental Technology	3	BK10A4200 Tuotesuunnittelu ja mallinnus/Product Design and Modeling	5	BH10A0001 Johdatus energiatekniikan opiskeluun/Introduction to Studies of Energy Technology	1
	BM20A5800 Funktiot, lineaarialgebra ja vektorit/Functions, Linear Algebra and Vectors	3	BH61A0000 Energiatalouden johdantokurssi/Fundamentals of Energy Economics	2	BM20A1501 Numeeriset menetelmät I/Numerical Methods I	3	BM20A4301 Johdatus tekniseen laskentaan/Introduction to Technical Computation	4
	BM30A2600 Mekaniikan perusteet/Basics of Mechanics	4	BL10A0100 Sähkötekniikan peruskurssi/Basics of Electric Engineering	3	BM20A5820 Integraalilaskenta ja sovellukset/Integral Calculus and Applications	3	BM20A5830 Differentiaaliyhtälöiden peruskurssiBasic/Course on Differential Equations	3
			BM20A5810 Differentiaalilaskenta ja sovellukset/Differential Calculus and Applications	4	BM30A2900 Aaltoliikeoppi/Wave Motion and Wave Phenomena	3	BM30A3000 Sähköoppi/Electricity and Magnetism	4
			BM30A2800 Lämpöoppi/Thermal Physics	4	FV13A0150 Svenska för teknologer/Swedish for Students in Technology	2	BH10A0900 Energiatekniikan laboratoriotyöt/Practical Measurements in Energy Technology	6
			CT60A0201 Ohjelmoinnin perusteet/Introduction to Programming	6	BH30A0001 Ydinenergian yleiskurssi/Introduction to Nuclear Energy	3		
			BH40A0702 Energiatekniikan mittaukset/Measurements in Energy Technology	2				
Compulsory studies, sum	*1 period*	9	*2 period*	24	*3 period*	19	*4 period*	18
Elective / optional courses / exchange studies (ECTS)								
All studies, sum	*1 period*	9	*2 period*	24	*3 period*	19	*4 period*	18

2. Academic year Compulsory courses in BSc in Energy Technology	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
	BH10A1400 Tekniikan kandidaatin tutkinnon työharjoittelu/Work internship in Bachelor's degree	2	BH20A0700 Teknillisen termodynamiikan perusteet/Fundamentals of Engineering Thermodynamics	2	BH40A1400 Virtaustekniikka I/Fluid Dynamics I	3	BM20A5840 Usean muuttujan funktiot ja sarjat/Functions of Several Variables and Series	3
	BK80A2900 Lujuustekniikan perusteet/Basic Course in Strength of Materials	3	BM20A1401 Tilastomatematiikka I/Statistics I	3	BH50A0500 Poltto- ja kattilatekniikan perusteet/Introduction to Combustion and Boiler Technology	5	BH20A0800 Teknillinen termodynamiikka/Engineering Thermodynamics	5
			FV18A2800 Tekniikan puhe- ja kirjoitusviestintä/Finnish Spoken and Written Communication for Engineers	3			BH40A1451 Virtaustekniikka II/Fluid Dynamics II	2
			Language studies	4			BH20A0200 Termodynamiikan harjoitus- ja laboratoriotyökurssi/Laboratory Course of Thermodynamics	3
							BH40A0101 Uusiutuva energia/Renewable Energy	3
							BH61A0200 Energiatalous/Energy Economics	4
Compulsory studies, sum	*1 period*	5	*2 period*	12	*3 period*	8	*4 period*	20
Elective / optional courses / exchange studies (ECTS)	Electives		Electives					
		4		4				
All studies, sum	*1 period*	9	*2 period*	16	*3 period*	8	*4 period*	20

3. Academic year Compulsory courses in BSc in Energy Technology	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
	BH40A0201 Pumput, puhaltimet ja kompressorit/Pumps, Blowers, Fans and Compressors	3	BH20A0300 Lämmönsiirron perusteet/Fundamentals of Heat Transfer	3	CS31A0210 Yritystalouden perusteet/The Basic Course of Business Economics	3	BH20A0450 Lämmönsiirto/Heat Transfer	3
			BH40A0301 Energianmuuntoprosessit/Applied Thermodynamics	3	BH50A0200 Voimalaitosopin perusteet/Introduction to Power Plant Engineering	4	BH20A0500 Lämmönsiirron harjoitus- ja laboratoriotyökurssi/Laboratory Course of Heat Transfer	3
							BH40A0401 Virtaus- ja lämpövoimakoneiden työkurssi/Applied Thermodynamics Laboratory Course	3
							BH10A0250 Energiatekniikan kandidaatintyön seminaari/Bachelor's Thesis Seminar of Energy Technology	2
							FV18A4001 Tekniikan tutkimusviestintä/Scientific Writing in Finnish	0
							BH10A0202 Energiatekniikan kandidaatintyö/Bachelor's Thesis in Energy Technology	10
Compulsory studies, sum	*1 period*	3	*2 period*	6	*3 period*	7	*4 period*	21
Elective / optional courses / exchange studies (ECTS)	Minor or exchange		Minor or exchange					
		10		10				
All studies, sum	*1 period*	13	*2 period*	16	*3 period*	7	*4 period*	21

According to the self assessment report the following **objectives** and **learning outcomes (intended qualifications profile)** shall be achieved by the Master's degree programme Energy Technology:

"After the completion of the Master's Programme in Energy Technology, students will be able to:

- analyse, design and select energy conversion processes for different applications, taking technological, economical, environmental and societal aspects into account
- apply and develop mathematical models to solve energy technology problems
- manage and organise both national and international projects
- communicate and operate in academic and research environments."

The following **curriculum** is presented:

1. period	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
BH40A0801 Turbomachinery	4	BH50A0300 Voimalaitosoppi	6	BH50A1701 District Heating	3	BH30A0302 Nuclear Power Plant Engineering	6
BL20A0900 Tiede, teknologia ja yhteiskunta	4	BH50A0800 Höyrykattilatekniikka	8	BH10A0701 Painelaitteet	2	BH61A0500 Puunjalostusteollisuuden energiatalous	6
		Language and communication studies	4				
1 period	8	*2 period*	18	*3 period*	5	*4 period*	12
Electives	6			Electives	7		
	14	*2 period*	18	*3 period*	12	*4 period*	12

1. period	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
		BH50A1300 Maintenace Management	4			BH10A1101 Diplomityö (Master's thesis)	30
		BH50A1800 Energiajärjestelmien suunnittelun perusteet	6			BH50A1900 Energiajärjestelmien kehitys	4
1 period	0	*2 period*	10	*3 period*	0	*4 period*	34
Minor subject studies	10	Minor subject studies or exchange	10				
1 period	10	*2 period*	20	*3 period*	0	*4 period*	34

According to the self assessment report the following **objectives** and **learning outcomes (intended qualifications profile)** shall be achieved by the Master's degree programme Energy Systems:

"After the completion of the Master's Degree Programme in Energy Systems, students will:

- be able to demonstrate a comprehensive understanding of the important technologies, practical applications, processes and actions concerning energy generation, power systems and energy markets, and the use of energy
- have adopted the principles of life cycle thinking and sustainable development in the domain of energy and the environment
- demonstrate a critical understanding of relevant theories and techniques, problem-solving skills, and the ability to use knowledge, equipment and tools independently for the design and development of practical applications
- be able to work with others in task-oriented groups, productively participating and interacting in the group
- be able logically to think through a problem and solve it, to contribute to innovative thinking, and to unambiguously communicate knowledge and solutions to the energy community and society, orally and in writing."

The following **curriculum** is presented:

1. Academic year Compulsory courses in MSc degree	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
	BH60A4400 Introduction to Sustainability	3	BH70A0002 Numerical Methods in Heat Transfer	6	FV11A6500 Presenting in English	2	BH60A4600 Introduction to M.Sc. Studies	1
	FV11A9800 Academic Writing in English Course 1	2	FV18A9201 Finnish 2	2	BH30A1901 Theoretical Nuclear Thermal Hydraulics	3	FV11A9900 Academic Writing in English Course 2	2
	FV18A9101 Finnish 1	2	BH30A0201 Nuclear Reactor Design	6				
			BH30A0701 Reliability Engineering	4				
			BH30A2104 Nuclear Reactor Dynamics	2				
Compulsory studies, sum	*1 period*	7	*2 period*	20	*3 period*	5	*4 period*	3
Elective / optional courses / exchange studies (ECTS)		5			Electives 5 ects	5	BH30A2200 Experimental Nuclear Thermal Hydraulics 3 ects	3
All studies, sum		12	*2 period*	20	*3 period*	10	*4 period*	6

2. Academic year Compulsory courses in MSc degree	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
			BH50A1300 Maintenace Management	4	BH30A1801 Nuclear Reactor Physics Analyses	3	BH10A2000 Master's Thesis	30
			BH50A1400 Steam Boilers	6				
			BH30A1701 Nuclear Reactor Physics Methods	3				
Compulsory studies, sum	*1 period*	0	*2 period*	13	*3 period*	3	*4 period*	30
Elective / optional courses / exchange studies (ECTS)	Minor subject studies or exchange		Minor subject studies or exchange					
			BH50A1200 Energy Systems Engineering 6 ects					
		10		16				
All studies, sum	*1 period*	10	*2 period*	29	*3 period*	3	*4 period*	30

According to the self assessment report the following **objectives** and **learning outcomes (intended qualifications profile)** shall be achieved by the Bachelor's degree programme Environmental Technology:

"Students who have completed their BSc degree in Environmental Technology are able to:

- define the fields of environmental technology, including their basic concepts, the central methods available, and related theories
- identify different emissions and their sources
- discuss the meaning of environmental technology, including its possibilities, challenges, and future visions also with experts from other fields
- follow and interpret the current legislation, and independently apply the legal norms related to environmental issues to practical work
- work in projects and teams consisting of experts from different fields
- report (e.g. on corporate environmental and social responsibility issues) in their mother tongue and in English
- gather and analyse scientific information related to environmental issues, and analyse the reliability of the sources."

The following **curriculum** is presented:

1. Academic year Compulsory courses in BSc degree	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
	BM20A5800 Funktiot, lineaarialgebra ja vektorit/Functions, Linear Algebra and Vectors	3	BM20A5810 Differentiaalilaskenta ja sovellukset/Differential Calculus and Applications	4	BM20A5820 Integraalilaskenta ja sovellukset/Integral Calculus and Applications	3	BM20A4301 Johdastus tekniseen laskentaan/Introduction to Technical Computation	4
	BM30A2600 Mekaniikan perusteet/Basics of Mechanics	4	BM30A2800 Lämpöoppi/Thermal Physics	4	BM30A2900 Aalto-liikeoppi/Wave Motion and Wave Phenomena	3	BM20A5830 Differentiaaliyhtälöiden peruskurssi/Basic Course on Differential Equations	3
	BH50A0001 Energiatekniikan peruskurssi/Introduction to Energy Technology	2	BH60A0000 Ympäristötekniikan perusteet/Basic Course in Environmental Technology	3	FV13A0150 Svenska för teknologer/Swedish for students in technology	2	BM30A3000 Sähköoppi/Electricity and Magnetism	4
	BJ01A1010 Yleinen kemia/General Chemistry	3	BH40A0702 Energiatekniikan mittaukset/Measurements in Energy Technology	2	CS31A0210 Yritystalouden perusteet/The Basic Course of Business Economics	3	BM20A5840 Usean muuttujan funktiot ja sarjat/Functions of Several Variables and Series	3
			BJ01A0020 Työturvallisuus laboratoriossa/Safety in Chemistry Laboratory	1			BH10A0900 Energiatekniikan laboratoriotyöt/Practical Measurements in Energy Technology	6
							BH60A3900 Johdatus ympäristötekniikan opiskeluun/Introduction to Studies of Environmental Technology	1
Compulsory studies, sum	*1 periodi*	12	*2 period*	14	*3 period*	11	*4 period*	21
Elective / optional courses / exchange studies (ECTS)								
All studies, sum	*1 period*	12	*2 period*	14	*3 period*	11	*4 period*	21

2. Academic year Compulsory courses in BSc degree	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
	FV18A2800 Tekniikan puhe- ja kirjoitusviestintä/Finnish Spoken and Written Communication for Engineers	3	BL10A0100 Sähkötekniikan peruskurssi/Basics of Electric Engineering	3	BK10A4200 Tuotesuunnittelu ja -mallinnus/Product Design and Modeling	5	BH20A0800 Teknillinen termodynamiikka/Engineering Thermodynamics	5
			BM20A1401 Tilastomatematiikka I/Statistics I	3			BH61A0200 Energiatalous/Energy Economics	4
			BH20A0700 Teknillisen termodynamiikan perusteet/Fundamentals of Engineering Thermodynamics	2			BH60A1301 Rakennusten energiatehokkuuden hallinta/Energy Efficiency Management of Buildings	7
			BH60A1600 Basic course on Environmental Management and Economics	5			BH60A1800 Ympäristöoikeuden perusteet/Introduction to Environmental Law	5
			BH61A0000 Energiatalouden johdantokurssi/Fundamentals of Energy Economics	2			BH60A2601 Ilmastonmuutos/Climate Change	5
			CT60A0201 Ohjelmoinnin perusteet/Introduction to Programming	6			BH60A0150 Projektityöskentely 1/Project work 1	4
Compulsory studies, sum	*1 periodi*	3	*2 period*	21	*3 period*	5	*4 period*	30
Elective / optional courses / exchange studies (ECTS)	Language studies from one language			2				2
All studies, sum	*1 period*	3	*2 period*	23	*3 period*	5	*4 period*	32

	1. period	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS

3. Academic year Compulsory courses in BSc degree	BH60A2900 Yritysvastuu ja johtaminen 1/Corporate Responsibility and Management 1	3	BH60A3600 Tekniikan kandidaatin tutkinnon työharjoittelu/Work internship in Bachelor's degree	2	BM20A1501 Numeeriset menetelmät I/Numerical Methods I	3	BH60A0901Ympäristömittaukset/Environmental Measurements	3
							BH60A4100 Ympäristötekniikan laboratoriotyöt/Laboratory Course of Environmental Measurements	4
							BH60A3401 Päästöjen ympäristövaikutukset/Environmental Impact of Emissions	3
							BH60A4001 Ympäristötekniikan kandidaatintyö/Bachelor's Thesis in Environmental Technology	10
							BH60A5100 Ympäristötekniikan kandidaatintyön seminaari/Bachelor's Thesis Seminar	2
Compulsory studies, sum	*1 periodi*	3	*2 period*	2	*3 period*	3	*4 period*	22
Elective / optional courses / exchange studies (ECTS)	Language studies from one language	10		9		5		5
	Elective studies							
	Minor studies							
All studies, sum	*1 period*	13	*2 period*	11	*3 period*	8	*4 period*	27

According to the self assessment report the following **objectives** and **learning outcomes (intended qualifications profile)** shall be achieved by the Master's degree programme Systainability and Science Solutions:

Students who complete their M.Sc. (Tech.) degree in Sustainability Science and Solutions

will be able to:

- take responsibility for managing environmental issues
- take responsibility for developing environmental issues
- anticipate the importance of sustainability challenges in the future
- work as a public environmental authority.

To describe the competences more precisely, the students who complete the degree will be able to:

- recognise the most significant environmental impacts of products and processes and their importance in terms of business
- understand the requirements of systemic change
- analyse how competitive in terms of environmental impacts and costs a certain technology, product or service is in different operating environments
- assess the technical possibilities of industrial, service, community, and primary production processes and systems to minimise environmental impacts
- explain the complex interdependencies of both local and global environmental problems
- apply theories and the most recent scientific knowledge to solve problems involving environmental aspects
- work as an environmental expert in a range of decision-making situations and produce and convey information to support stakeholders in environmental decisionmaking
- adopt and innovate new technical solutions to develop the environmental sector."

The following **curriculum** is presented:

1. Academic year Compulsory courses in MSc degree	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
	BH60A4500 Corporate Responsibility and Management 1*	3	BH60A0252 Solid Waste Mangement Technology	7	BH60A3501 Sustainable Innovation and System Transition	5	BH60A2101 Advanced Course in Life Cycle Assessment	7
			BH60A0451 Air Pollution Control	6			BH60A3001 Corporate Responsibility and Management 2	5
			BH60A1201 Indoor Climate Management of Buildings	7			BH60A4700 Climate Finance and Carbon Markets	3
							BH60A4600 Introduction to M.Sc. Studies*	1
Compulsory studies, sum	*1 periodi*	3	*2 periodi*	20	*3 periodi*	5	*4 periodi*	16
Elective / optional courses / exchange studies (ECTS)	Language Studies							
	Elective Studies							
	Minor Studies							
				7		5		7
All studies, sum	*1 period*	3	*2 period*	27	*3 period*	10	*4 period*	23

2. Academic year Compulsory courses in MSc degree	**1. period**	ECTS	**2. period**	ECTS	**3. period**	ECTS	**4. period**	ECTS
			BH60A0652 Sustainable Water Use	6			BH60A2701 Energy Efficient Environment	6
							BH60A5000 Master's Thesis	30
Compulsory studies, sum	*1 periodi*	0	*2 periodi*	6	*3 periodi*	0	*4 periodi*	36
Elective / optional courses / exchange studies (ECTS)	Elective Studies							
	Minor Studies							
		5		5		5		
All studies, sum	*1 period*	5	*2 period*	11	*3 period*	5	*4 period*	36