Course catalogue

Master's programme

Energy Science

2016-2017

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Preface

Welcome to the Master's programme Energy Science.

The Master's programme Energy Science is part of the Graduate School of Geosciences and is organised by the Department of Innovation, Environmental and Energy Sciences. The programme aims to teach you the specialised knowledge and professional attitudes and skills you need to become a first class researcher in academic and professional organisations in the field of energy science. The close link to the excellent research of the Copernicus Institute of Sustainable Development, combined with the small scale of the groups, the international setting of the Master's programme and the pleasant working atmosphere will contribute to this aim.

We hope this course catalogue will help you to find the relevant information you need as a student in the Master's programme easily. First you will find a general description of the programme, the structure, the components and some organisational matters. This is followed by a description of all courses of the two year programme. Information about procedures, a list of staff members, and the UU-time table is also included in the catalogue. The Teaching and Examination Regulations 2016-2017 (OER) can be found in Appendix II and the Regulations of the Board of Examiners will be published separately on the website.

At any time during your studies you will need two course catalogues: one of the year you started your Master's programme in Energy Science (this shows the exam programme that you need to follow) and one of the most recent academic year, which shows the current rules and regulations.

You can find more information on the website at: http://students.uu.nl/en/geo/energy-science. Still, if you have some (personal) questions, you can contact the student advisor of the programme or contact the programme leader.

On behalf of the staff we wish you an inspiring, pleasant and successful new academic year!

Dr. ir. Andrea Ramirez, Programme Leader Master Energy Science
Dr. Margien Bootsma, Director of Education Innovation, Environmental and Energy Sciences

1 Content of the programme

1.1 Introduction

Energy is of paramount importance to society. The development of the global energy system is closely linked to the economic and technological development of society. There are enormous challenges ahead of us, such as mitigating climate change, securing our long term energy supply and providing access to clean and efficient energy for everyone. There is broad consensus that we need to work on a transition to a sustainable energy system, of which energy efficiency and renewable energy are key components.

The Master's Programme Energy Science will provide you with a deep understanding on how energy systems work, and how they can be analysed and modeled. Your will also get detailed insight into current and future energy technologies. However, the scope of the programme is much broader: you will also learn about energy economics and energy and climate policies.

1.2 Mission of the Master's programme

The aim of the Master's programme Energy Science is:

To educate natural scientists and engineers to be able to contribute to the transitions towards sustainable energy systems, by doing applied research, by working in the energy industry, doing consultancy work or being employed in governmental organisations dealing with energy and environmental issues.

1.3 Relation between the Master's programme and the Copernicus Institute

The Master's programme is closely affiliated to the Copernicus Institute of Sustainable Development, which is part of Utrecht University. The research conducted at the Copernicus Institute covers a wide range of issues related to sustainable development and innovation. The starting point of all research is the source-impact chain that links economic activities with ecological values. For more information on the research programme, research themes and groups of the Copernicus Institute, see: http:www.uu.nl/Copernicus.
Most of the energy-related research in the Copernicus Institute is carried out in the group Energy and Resources, led by prof. dr. Ernst Worrell. The research of this group covers a variety of topics, including energy efficiency in manufacturing industry, bio-energy, biomaterials, carbon-capture-and-storage, solar photovoltaic energy, power system modelling and smart grids. Majority of the teachers in the Energy Science programme are part of this group.

1.4 Competence profile and occupational perspectives

The MSc programme Energy Science has the following degree qualifications:

The graduate:

1. has advanced knowledge and understanding of the dynamics and challenges of Energy Science in the context of both organisations and society at large; in particular of energy production, consumption and the consequences of energy

production and energy use for people, the economy, the environment and future generations;
2. is able to conduct research on the dynamics and challenges of Energy Science in a creative and independent way; in particular research methods for energy system analysis and new multidisciplinary research on energy systems at various scales (micro, regional, national and international) and the graduate can apply these methods in research on energy systems;
3. has the ability to apply knowledge and research methods, and problem-solving abilities in broader contexts related to the dynamics and challenges of Energy Science; in particular the ability to design strategies to make energy systems sustainable in a creative and independent way;
4. has insight into the complex interactions between science, innovative technology and society and is able to reflect critically upon the roles of science and technology in society;
5. has professional and academic skills, in particular in relation to the dynamics and challenges of Energy Science;
6. is able to apply knowledge and understanding in such a way that he or she demonstrates a professional approach to their work;
7. is able to communicate conclusions, as well as the knowledge, reasons and considerations underlying these conclusions, to an audience of specialists and non-specialists alike.

Career perspectives
The development of sustainable energy systems is one of the Grand challenges of this century. Research institutes as well as governmental and non-governmental organizations are active in the quest for increasing energy efficiency and more renewable energy sources. Many existing and new companies are taking up the challenge to develop new business in this area and there is already a large demand for energy and resources specialists, which will certainly increase in the years to come. Job opportunities include:

- Academic occupations: Graduates are able to find employment in the private sector (energy and gas companies, such as Shell, NAM, Gasunie, Vattenvall, Essent, Eneco); public sector (Ministry of Economic Affairs, Ministry of Environment; Tennet, Provinces, energy agencies); consultancy (Ecofys, DNV GL, Jacobs, KPMG, DHV, Arcadis) and NGOs (Greenpeace, WWF, Stichting Natuur en Milieu). Graduates can also find positions at international bodies, such as the European Union, the Environment Foundation for Africa, the Organisation of American States and the International Energy Agency.
- Scientific occupations: The programme prepares students for a Ph.D., ultimately leading to professions in scientific research. Graduates of the programme must be capable of writing a Ph.D. dissertation. Possible employers: Universities, ECN, RIVM, TNO and similar institutes in other countries.

Alumni network
The Energy Science programme likes to stay in touch with its alumni. A LinkedIn group has been created and is named "Energy Science Utrecht University". Students are invited to subscribe.
The student association NRG organises alumni events once per year.

1.5 Curriculum

Energy Science is a 2 year full-time Master's programme (120 EC).

Two tracks exist:

- Systems Analysis. In this track the student receives an all-round training in all aspects of energy systems, including technology, economics and policy. In this

track students complete a consultancy project (15 EC) and a Master's thesis (30 EC).
- Natural Science. In this track, the students get familiar with energy systems and energy systems analysis, but the focus is more on the scientific and technological aspects. In this track students complete a Natural Science Research Project (30 EC) and a Master's thesis (30 EC).

The Systems Analysis track consists of 52.5 EC mandatory courses, 37.5 EC elective courses and a 30 EC Master's thesis. The Natural Science track consists of 37.5 EC mandatory courses, 22.5 EC elective courses and 60 EC of research projects and Master's thesis.

1.6 Systems Analysis track

Mandatory courses
- Energy in the Context of Sustainability (GEO4-2514) 7.5 EC
- Energy Conversion Technologies I (thermal/chemical) (GEO4-2502) 7.5 EC
- Advanced Energy Analysis (GEO4-2508) 7.5 EC
- Energy Conversion Technologies II (physical/mechanical) (GEO4-2503) 7.5 EC
- Energy Systems Modelling (GEO4-2515) 7.5 EC

Research projects and practical work
- Consultancy project (GEO4-2519) 15 EC
- Master's thesis (GEO4-2510) 30 EC

Elective courses
Students should select courses for a total of 37.5 EC. Rules for choosing electives are described in Appendix I.

The course calendar 2016-2017 can be found in section 1.9.

Master's thesis and internship in the systems analysis track

In the last stage of the Master's programme Energy Science, Systems Analysis track, a Master's thesis (research project) is conducted. An internship can be conducted as an elective course.

The main differences between the Master's thesis and the internship are summarized in the table below.

	Master's thesis	**Internship**
Main aim	Learn how to do research	Learn to be a professional
Location	Internal at UU, at another university or at a research institute or another environment with sufficient academic level	External , in general not a research institute

1.6.1 Master's thesis Systems Analysis track

This is a research project in which the student will learn to conduct research independently, whereby new methods are developed and/or accepted or existing methods are applied to a new problem. The research should be relevant from both a scientific point of view (it should expand the body of scientific knowledge) and a societal point of view (it should produce knowledge that can contribute to a better understanding or the solution of societal problems in the area of energy). Information on procedures,

entrance requirements, place of research, output etc. can be found in the course description in this catalogue and in the course manual Master's thesis Energy Science.

1.6.2 Internship Systems Analysis track

The internship (GEO4-2520) is an opportunity to become acquainted with the practices one will later encounter in the work place. It is an applied research or consultancy project that contributes to solving a problem in the field of energy and materials and at the same time is relevant to policy and/or management.
The internship should meet the following criteria:

- The internship has a weight of 22.5 EC, which is equivalent to 15.75 fulltime working weeks (40 hours per week).
- During the internship you preferably should work on a single assignment (rather than multiple small tasks) at the host institution. If this is not the case, you need to discuss this in advance with your UU supervisor and this should be reflected in your internship research proposal. Your work will result in a report.
- The internship research proposal is to be submitted within 4 weeks after you and your supervisor have agreed on starting an internship procedure.
- An internship contract between the host institution and the university is **mandatory**. Always let your UU supervisor check **before** you sign the contract. If the host does not provide you with a contract you can use the UU internship contract.
- A staff member of the Department (the responsible lecturer or "academic supervisor") and a person at the host institution (the "daily supervisor") are responsible together for guiding and supervising the student.
- Your report will be assessed, in first instance, by the host supervisor. The final assessment will be made by the academic supervisor, who will be the person who is responsible for grading.

Information on procedures, entrance requirements, place of research, output etc. can be found in the course description in this catalogue and in the course manual Master's thesis Energy Science, which can be found on the Blackboard Community Energy Science. The Faculty of Geosciences has its own digital internships database: http://internships.geo.uu.nl.

1.6.3 Combining the Master's thesis with an internship

The internship can be connected with the Master's thesis. It may have added value to do more in-depth research on a topic that you encountered during the internship. Or an internship may be an opportunity to explore the practical side of a topic that you work on in a research project.
In either case, the thesis and the internship are seen as two courses and each has its own course objectives and deliverables. At the very least, this means two reports need to be written and two presentations made. The exact deliverables can be found in the course descriptions.

For further questions you can contact the coordinator of the Master's thesis: dr. ir. C.A. Ramirez, c.a.ramirez@uu.nl (tel: 030-2537639).

1.7 Natural Science Track

Mandatory courses

- Energy in the Context of Sustainability (GEO4-2514) 7.5 EC
- Energy Conversion Technologies I (thermal/chemical) (GEO4-2502) 7.5 EC
- Advanced Energy Analysis (GEO4-2508) 7.5 EC
- Energy Conversion Technologies II (physical/mechanical) (GEO4-2503) 7.5 EC
- Energy Systems Modelling (GEO4-2515) 7.5 EC

Mandatory electives
Two natural science courses (15 EC) need to be completed, e.g.:
SK-MAKC, Adsorption, Kinetics and Catalysis
SK-MSYNA Synthesis of heterogeneous Catalysts
SK-MSOLS Solids and Surfaces
SK-MNCCN: Nanomaterials: Catalysis, Colloids, Nanophotonics
NS-NM429M: Soft Condensed Matter
NS-TP432M: Modelvorming en simulatie
GEO4-2513 Solar Energy Physics
GEO4-1426: Kinetic Processes
GEO4-1410: Mechanisms of deformation and transport in rocks
GEO4-1434: Principles of groundwater flow
GEO4-1425: Earth resources, mineral and petroleum resources: integrated exploration modelling
GEO4-6001: Quantitative Water management

Free elective courses
Students should select courses for a total of 7.5 EC. Rules for choosing electives are described in Appendix I.

Master's thesis and practical work

Natural Science Research Project (GEO4-2518)	30 EC
Master's thesis (GEO4-2510)	30 EC

The course calendar 2016-2017 can be found in section 1.9.

1.7.1 Natural Science Research Project and Master's thesis in the Natural Science track

Within the track Natural Science two different periods of research are obligatory. Firstly, a Natural Science Research Project is to be performed in the field of natural science and amounts to 30 EC. It is a research project in which the student will learn to conduct research independently in an energy-related natural science field.
The research should be relevant from both a scientific point of view (it should expand the body of scientific knowledge) and a societal point of view (it should produce knowledge that can contribute to addressing energy-related problems in society). Many groups in the Science Faculty and the Faculty of Geosciences perform basic and/or applied research related to energy, and the variant Natural Science offers students an opportunity to take advantage of this. The research could also be performed at another (inter)national Science Faculty.

Secondly, a topic in the field of Energy Science must be selected to complete the Master's Programme with a Master's thesis, amounting to 30 EC.

The Thesis and the Natural Science Research Project are seen as two courses and each has its own course objectives and deliverables. At the very least, this means two reports need to be written and two presentations made. The exact deliverables for each course can be found in the course descriptions and in the course manual Master's thesis Energy Science.

Information on procedures, entrance requirements, place of research, output etc. can be found in the course description in this catalogue and in the course manual Master's thesis Energy Science, which can be found on the Blackboard Community Energy Science.

1.8 Elective courses

Elective courses Systems Analysis track
Students should select courses for a total of 37.5 EC.
Possible electives include an internship for 22.5 EC (GEO4-2520), the course Writing a scientific article (GEO4-2516, by invitation only), the Tailor-made course (GEO4-2517), Bio-based Economy (GEO4-2521) or other additional elective course(s).

Elective courses Natural Science track
Students should select one free elective course of 7.5 EC.
Furthermore, students in the Natural Science track should choose at least two natural science courses (15 EC), selected from the list mentioned in section 1.7.

The following rules should be taken into account:

The elective course should always be approved in advance by the Board of Examiners. The procedure is described in Appendix I of this course catalogue.
The elective course should be at Master level and should be related to the subject of energy or relevant for the Research Project/Master's thesis.

In the programme's planning room has been scheduled for taking electives. However, the student is free to deviate from this planning, e.g. because (s)he wishes to take an interesting elective course taught in another period. If this causes delay in study planning, the responsibility is for account of the student! Students are therefore strongly advised to take their electives in the reserved periods and timeslots, or use a part of these timeslots for the first part of the research project/master's thesis.

1.9 Course schedules 2016-2017

1.9.1 Course schedule ES (Systems Analysis) 2016-2017

Bold and underlined = obligatory course
Normal = free elective

Year 1 (intake 2016)

Period 1	**(A) Energy in the Context of Sustainability, GEO4-2514**	**(C) Energy Conversion Technologies I, GEO4-2502**
Period 2	**(D) Advanced Energy Analysis GEO4-2508**	**(A) Energy Conversion Technologies II, GEO4-2503**
Period 3	**(A) Energy Systems Modelling, GEO4-2515**	Elective (7.5 EC), e.g. (B) Bio-based Economy, GEO4-2521
Period 4	**(A+B+C+D) Consultancy Project ES, GEO4-2519 (15 EC)**	

Year 2 (intake 2015)

Period 1 - 4	**Master's thesis, GEO4-2510 (30 EC)** Internship Energy Science, GEO4-2520 (22.5 EC) *and* Additional electives (7.5-15 EC) Or: Additional electives (30-37.5 EC)

Students should select electives for a total of 37.5 EC. They can be divided as follows:
- Internship (GEO4-2520) 22.5 EC and 15 EC electives, or
- 37.5 EC electives

Recommended electives
See website: http://students.uu.nl/en/geo/energy-science/academics/study-programme/electives
Recommended electives do not need to be approved by the programmeleader but must still be approved *before starting* by the Board of Examiners.

intake 2012 and earlier

Period 1 - 4	**Internship Energy Science SA, GEO4-2509, (18,75-26,25 EC)** **Research Project SA/Master's thesis, GEO4-2510 (30 – 37,5 EC)**

1.9.2 Course schedule ES (Natural Science) 2016-2017

Bold and underlined = obligatory course
Italics and underlined =obligatory electives: 2 natural science courses
Normal = free elective

Year 1 (intake 2016)

Period 1	**(A) Energy in the Context of Sustainability, GEO4-2514**	**(C) Energy Conversion Technologies I, GEO4-2502**
Period 2	**(D) Advanced Energy Analysis GEO4-2508**	**(A) Energy Conversion Technologies II, GEO4-2503**
Period 3	**(A) Energy Systems Modelling, GEO4-2515**	elective (7.5 EC) e.g. (B) Bio-based Economy, GEO4-2521 or *Natural science course*
Period 4	**Natural Science Research Project, GEO4-2518 (30 EC)** Or: Elective (7.5 EC) *Natural science course*	

Year 2 (intake 2015)

Period 1 - 4	**Natural Science Research Project, GEO4-2518 (30 EC)** *Natural science course* Or: Elective (7.5 EC) **Master's thesis, GEO4-2510 (30 EC)**

Two Natural Science courses need to be completed, e.g.:
SK-MAKC, Adsorption, Kinetics and Catalysis
GEO4-2513 Photovoltaic Solar Energy Physics and Technology (4A)
SK-MSYNA Synthesis of Heterogeneous Catalysts
SK-MSOLS Solids and Surfaces
NS-NM429M: Soft Condensed Matter (7.5 EC)
GEO4-1426: Kinetic Processes (7.5 EC)
GEO4-1410: Mechanisms of deformation and transport in rocks (7.5 EC)
GEO4-1434: Principles of groundwater flow
GEO4-1425: Earth resources, mineral and petroleum resources: integrated exploration modelling
GEO4-6001: Quantitative Water management (7.5 EC)
SK-MNCCN: Nanomaterials: Catalysis, Colloids, Nanophotonics (7.5 EC)
NS-TP432M: Modelvorming en simulatie (7.5 EC)

Recommended electives
See website: http://students.uu.nl/en/geo/energy-science/academics/study-programme/electives
Recommended electives do not need to be approved by the programmeleader but must still be approved *before starting* by the Board of Examiners. Students should select electives for a total of 7.5 EC.

Year 2 (intake 2012 and earlier)

Period 1 - 4	*Natural science course* **Natural Science Research NS, GEO4-2511, (22,5 - 30 EC)** **Energy Science Research NS, GEO4-2512, (22,5 – 30 EC)**

1.10 Entrance requirements

Some courses carry entrance requirements and/or recommended prerequisites. The table below show which courses in the Energy Science programme carry which requirements.

In case of a discrepancy between the entrance requirements and/or recommended pre-requisites mentioned in this course catalogue and the ones mentioned in the electronic UU course offerings database 'Osiris', the entrance requirements and/or recommended pre-requisites mentioned in the table below are leading.

Course	Entry requirements/recommended prerequistes
Energy conversion technologies I (GEO4-2502)	Recommended prerequisites: - Knowledge of Elementary thermodynamics and calculus
Energy conversion technologies II (GEO4-2503)	Recommended prerequisites: - Knowledge of Elementary thermodynamics and calculus
Advanced Energy analysis (GEO4-2508)	Recommended prerequisites: - Knowledge of Energy Analysis and calculus
Internship Energy Science (SA) (GEO4-2509) (old cohorts)	- Obligatory for and only open to cohorts 2012 and earlier, Systems Analysis track - Letter of acceptance MSc Energy Science - At least 45 EC passed within the programme Energy Science including Advanced Energy Analysis (GEO4-2508) Recommended prerequisites: - Consultancy Project (GEO4-2501 or GEO4-2519)
Master's thesis (GEO4-2510) (new cohorts)	- Letter of acceptance MSc Energy Science - At least 45 EC passed within the programme Energy Science including Advanced Energy Analysis (GEO4-2508) and at least 3 out of the following courses: Energy in the Context of Sustainability (GEO4-2514), Energy Conversion Technologies I (GEO4-2502), Energy Conversion Technologies II (GEO4-2503), Energy Systems Modelling (GEO4-2515) Recommended prerequisites: - Consultancy Project (GEO4-2519)
Research Project SA (GEO4-2510) (old cohorts)	- Obligatory for and only open to cohorts 2012 and earlier, Systems Analysis track - Letter of acceptance MSc Energy Science - At least 45 EC passed within the programme Energy Science including Advanced Energy Analysis (GEO4-2508)
Natural Science Research NS (GEO4-2511) (old cohorts)	- Obligatory for and only open to cohorts 2012 and earlier, Natural Science track - Letter of acceptance MSc Energy Science - At least 45 EC passed within the programme Energy Science - At least two of the following five courses: Photovoltaic Solar Energy Physics and Technology (GEO4-2513) (or Device Physics (NS-NM426M)), Adsorption, Kinetics and Catalysis (SK-MAKC), Synthesis of heterogeneous Catalysts (SK-MSYNA) or Solids and Surfaces (SK-MSOLS) of which the latter three are from the Science Master Curriculum

Energy Science Research NS (GEO4-2512) (old cohorts)	- Obligatory for and only open to cohorts 2012 and earlier, Natural Science track - Letter of acceptance MSc Energy Science - At least 45 EC passed within the programme Energy Science including Advanced Energy Analysis (GEO4-2508) - At least two of the following five courses: Photovoltaic Solar Energy Physics and Technology (GEO4-2513) (or Device Physics (NS-NM426M)), Adsorption, Kinetics and Catalysis (SK-MAKC), Synthesis of heterogeneous Catalysts (SK-MSYNA) or Solids and Surfaces (SK-MSOLS) of which the latter three are from the Science Master Curriculum
Photovoltaic Solar Energy Physics and Technology (GEO4-2513)	Recommended prerequisites: - Basic knowledge of solid state physics or condensed matter physics
Energy in the Context of Sustainability (GEO4-2514)	- Letter of acceptance MSc Energy Science or MSc Innovation Sciences
Energy Systems Modelling (GEO4-2515)	Recommended prerequisites: - Energy Analysis (GEO3-2223) - Advanced Energy Analysis (GEO4-2508)
Writing a scientific article (GEO4-2516)	- Letter of acceptance MSc Energy Science - Minimum mark of 8.0 for Master's thesis or Natural Science Research Project AND - invitation from Master's thesis's or Natural Science Research Project's supervisor.
Tailor made course ES (GEO4-2517)	- Letter of acceptance MSc Energy Science - At least 45 EC passed within the programme
Natural Science Research Project (GEO4-2518) (new cohorts)	- Obligatory for and only open to cohorts 2013 and later, Natural Science track - Letter of acceptance MSc Energy Science - Advanced Energy Analysis (GEO4-2508) and at least 3 out of the following courses: Energy in the Context of Sustainability (GEO4-2514), Energy Conversion Technologies I (GEO4-2502), Energy Conversion Technologies II (GEO4-2503), Energy Systems Modelling (GEO4-2515) Recommended prerequisites: - At least two natural science electives.
Consultancy project (GEO4-2519)	- Letter of acceptance MSc Energy Science - Only open to students in track Systems Analysis Recommended prerequisites: - Advanced Energy Analysis (GEO4-2508) - Energy Systems Modelling (GEO4-2515)
Internship Energy	- Only open to cohorts 2013 and later - Only open to students in track Systems

Science (GEO4-2520) (new cohorts)	Analysis - Letter of acceptance MSc Energy Science - Advanced Energy Analysis (GEO4-2508) and at least 3 out of the following courses: Energy in the Context of Sustainability (GEO4-2514), Energy Conversion Technologies I (GEO4-2502), Energy Conversion Technologies II (GEO4-2503), Energy Systems Modelling (GEO4-2515) Recommended prerequisites: - Consultancy Project (GEO4-2519)
Bio-based Economy (GEO4-2521)	Recommended prerequisites: - Advanced Energy Analysis (GEO4-2508) - Life Cycle Analysis (GEO3-2124; BSc course) - Toolbox 1 (GEO4-2602) - Science and technology for Sustainable development (SK-BCHDO; BSc course)

1.11 Conversion of former courses

Please notice that some of the courses from the programme 2015-2016 and before have been replaced or renamed.

The following courses from 2015-2016 and earlier are replaced or renamed as follows:

Old course	***New course 2016-2017***
Solar Energy Physics (GEO4-2513)	Photovoltaic Solar Energy Physics and Technology (GEO4-2513)
Advanced Topics in ES (GEO4-2517)	Tailor made course ES (GEO4-2517)

1.12 Profile Complex Systems, Annotation Sustainable Entrepreneurship & Innovation, Climate KIC EIT Master Label, Young Innovators Programme and SENSE Honours Programme

1.12.1 Profile Complex Systems

The world around us is becoming more and more complex. A small change in one variable can have a significant impact, resulting in e.g. traffic jams, a sudden epidemic or a financial crisis. Complex Systems are often the driving force behind these phenomena. As a whole they possess characteristics which cannot be deducted simply from its individual parts, but only from the way in which these are combined together. Predicting a traffic jam is e.g. hardly possible by only studying the behavior of individual drivers. The whole is bigger than the sum of its parts.
The profile Complex Systems is an interdisciplinary profile for ambitious students from different Master's programmes, who want to work on modelling solutions within the field of Complex Systems. The profile gives you the opportunity to broaden your view and knowledge from an interdisciplinary angle and widens your opportunities for further development. It prepares you for a career in interdisciplinary fields at, for instance, financial companies.
This profile can be fitted into your Master's programme, 30 EC in total. You will receive a Complex Systems certificate.

In order to qualify for the annotation, the following requirements must be fulfilled:

Courses (15 EC)
Having passed the examinations of two (elective) courses:
- Energy Systems Modelling (GEO4-2515; 7,5 EC)
- a choice of one from the following courses:
- Introduction to Complex Systems, code WISM484 (7,5 EC; period 1-2)
- Applying Mathematics in Finance, code WISM410 (7,5 EC; period 3-4)
- Measuring the health effect of ionizing radiation, code WISM409 (7,5 EC; period 3-4)

Or a course from a Master's programme, other than your own, that is labelled as a **Complex Systems course**

Thesis (15 EC)
A research project/literature study on a topic in the field of complex systems. Focus should be on interdisciplinary aspects and at least two supervisors from different departments/faculties should be involved. The topic may not correspond with the topic of your Master's thesis. The topic should be approved by the steering group members of the Foundations of Complex systems focus area who are involved and by the programme director of your Master's programme.

The total number of EC will NOT be increased by completing the Master profile Complex Systems.

If you have questions about the profile, please ask your Master's programme leader for more information.
You can apply for this Master profile by sending an email to the coordinator Complex systems: Quirine Laumans
More information about the research on Complex Systems.

1.12.2 Annotation Sustainable Entrepreneurship & Innovation

The Master Annotation Sustainable Entrepreneurship & Innovation is a university wide Master track that aims to deliver world leading change agents in the area of sustainability. Students enrolled in the Master's programme Energy Science can qualify themselves for the annotation Sustainable Entrepreneurship & Innovation next to their Master's degree ES and will obtain an additional certificate. In order to qualify for the annotation, the following three requirements must be fulfilled:

1) having passed the examinations of one of these two elective courses:
- Technology Related Venturing (GEO4-2268; 7,5 EC) with an assignment regarding a sustainability subject;

or:
- Sustainable Entrepreneurship (ECMSE; 7,5 EC).

2) having passed the examinations of one of these elective courses, which may not be the same course as the course passed for fulfillment of requirement 1 mentioned above:
- GEO4-2521: Bio-based economy
- GEO4-2514: Energy in the Context of Sustainability
- GEO4-2312: Sustainable Energy Supply
- GEO4-2604: Organisational Change Management for SD
- GEO4-2268: Technology Related Venturing
- ECMSE: Sustainable Entrepreneurship

3) having conducted a research project of ≥15 EC on the start and implementation of new activities in the area of sustainability within new or established organizations. Sustainability is defined as the fulfillment of basic human needs without undermining the capacity of the environment to fulfill the needs of present and future generations.

The requirements for the research component are:
- It is about newly developed or to be developed sustainable production processes, products, and/or services created by firms (within established and/or new start-ups);
- These activities need to be new to the current business activities of these firms;
- It needs to include some form of data collection about these new business activities;
- This research component should be at least 15 EC of the Master's programme.

In the research proposal students have to stipulate the fit of their research proposal to these 4 requirements in a separate section.
If you decide to undertake the annotation, please indicate this on the form for choosing elective courses: http://students.uu.nl/sites/default/files/geo-iees-application_form_optional_courses.pdf

In order to qualify for the third requirement, you should indicate the choice for the annotation on the Master's thesis research proposal information form. Once you have completed the Master's thesis, it will be checked whether it meets the requirements. If you have met all requirements for the annotation, you will be awarded an annotation certificate together with your Master's degree certificate.

1.12.3 Climate-KIC EIT Master Label

For a small number of excellent students, Climate-KIC, part of the European Institute of Innovation and Technology (EIT), offers the Climate-KIC EIT Master Label. It allows selected MSc students to explore climate science and sustainable entrepreneurship alongside their regular master courses.

For ES master students, this programme consists of:
- Annotation Sustainable Entrepreneurship & Innovation (see 1.12.2).
- a five week climate innovation summer school - The Journey
- a series of thought-provoking SPARK! talks and seminars
- 12 EC complementary elective courses in related subjects
- 30 EC of your Master's programme outside of your home university, e.g. by doing an internship or thesis research (up to 6 months of financial support is available if the EC are earned abroad).
- Master thesis on a topic related to climate change and entrepreneurship

Students who complete the Climate-KIC EIT Master Label will receive the EIT Master Label certificate. *It is not possible to receive both the EIT certificate and the annotation certificate.* More information on the programme and the enrolment procedure is available at: http://www.climate-kic.nl

1.12.4 Young Innovators Programme

Utrecht University offers the Young Innovators Programme to high-achievers with leadership potential. Young Innovators Programme is a selective 15 EC honours course at graduate level, to be taken on top of any master's programme.

The programme is focused on learning to research, design and deliver innovative and sustainable solutions to real-life societal challenges. Supported by leading researchers

from the university's strategic research theme of Institutions, the programme allows you to immerse yourself in the theory and practice of innovation across the corporate, public and community sectors. It stimulates you to collaborate, produce and learn in multidisciplinary teams. It will inspire you by providing the opportunity to engage with exemplary innovators and leaders who will share their experience in masterclasses.
In the first four months of the programme, participants will learn to think about and study the art and science of innovation across a range of sectors. They will group into teams and begin to explore concrete problems and projects, for which they will seek to actively create innovative, research-driven interventions in the second semester.

The programme will focus on exploring and designing innovations in three areas:
- Sustainable innovations in health
- Sustainable innovations in the economy
- Sustainable innovations in urban living

These multifaceted themes demand the joint efforts of experts from the sciences and humanities alike. They require knowledge of energy, climate dynamics, food, technology, and health. However, insights into the dynamics of societies, law and economics, languages and cultures or history and philosophy are just as essential.

The issues transcend national and cultural borders. Therefore, the programme aims at a substantial participation of international students and is taught in English.

As a participant you will:
- become part of a community that serves as an inspiring learning environment and will provide the basis for your professional network;
- work in interdisciplinary teams on topics within the themes above;
- prepare for and participate in weekly Tuesday night sessions throughout the year (compulsory attendance), as well as two weekend and several assorted nighttime sessions;
- participate in 6 team coaching sessions where you will be encouraged to improve your collaborative potential through reflecting on your team's process and progress;
- present your team's work-in-progress at several plenary conferences; and
- enhance your international profile by taking part in a summer school of your choice at a university abroad.

Interested in this programme? Learn more about the admission requirements? http://www.uu.nl/masters/en/general-information/international-students/about-utrecht-university/young-innovators.

1.12.5 SENSE Honours Programme

The SENSE Honours Programme offers 12 to 15 excellent **MSc students** from SENSE related MSc programmes the opportunity to follow a special "research master track" in the second year of their MSc programme. This track prepares you for an academic research career by writing a full PhD research proposal on a subject of your own choice, which fits into the SENSE research theme "Sustainability Sciences". At the end of the MSc Honours Programme the candidates are encouraged to continue their research as PhD candidate at one of the participating SENSE research groups. The SENSE research groups will help you to find external funding for your PhD proposal or to find a position as PhD candidate at one of the research groups.

Excellent MSc students are nominated by professors, thesis supervisors, lecturers or by the coordinator of the participating MSc programmes. MSc students who are interested in the programme, please contact your thesis supervisor, lecturer or MSc programme

coordinator. The nomination and selection procedure of an excellent MSc student can be found here: Nomination and selection MSc students SENSE Honours Programme

For more information, contact Monique Gulickx: monique.gulickx@sense.nl

2. Didactics, study management and practical matters

2.1 Educational format

Activating education
The educational philosophy of the Master's programme is problem-orientated, which calls for a proactive teaching format. Problem-orientated education takes a concrete problem as the point of departure for the learning process. The acquisition of knowledge and skills is related to the analysis and/or solution of the problem in question. "Activating education" is a form of teaching whereby the students themselves are largely in control of the learning process. They take their education into their own hands by doing individual or group assignments, taking part in debates or simulation games, and applying the methods they have learned. A proactive educational format calls for intensive back-up on the part of the instructor in the form of study guidelines, instructions, manuals, and feedback on the students' performance. The students mainly work in small groups.

Active input of instructors and students
The objective of the Master's programme is to offer an inspiring and high-quality environment for study. The goal is to work together with the student to maximise the transfer of knowledge. All of the instructors and support staff involved in the programme operate on the assumption that if the student is fully dedicated to the study, they can offer the greatest possible guarantee that the student will pass all of the individual courses.

Required attendance
For various parts of the study, attendance is mandatory. This applies to working groups, field trips, simulation games, etc. The course manual for each course stipulates exactly which sessions the student is required to attend. As stated in article 4.4 of the Education and Examination regulations, exceptions to mandatory attendance can only be made if the student can prove that his absence is due to reasons beyond his control (special circumstances due to e.g. illness or family circumstances).

Report ill in time
If you cannot attend an obligatory preliminary or other exam, lecture or working group, please phone the department's secretariat *prior* to the meeting, and by 9.30 a.m. at the latest: 030 – 253 2359 or 030 – 253 1625.

Absence or illness does not relieve you of your obligation to perform to the best of your ability. In other words, if you have not been able to complete a paper or give a presentation, contact the Course Coordinator to find out if it can be rescheduled for another date.
If the quality or quantity of your attendance has been insufficient, the Course Coordinator may exclude you from the remainder or part of the course.

Testing
There are multiple points during a course in which the student is tested. Thus, the final evaluation for a course does not depend solely on a final exam. As a rule, there are opportunities for feedback and improvement, depending on how the course is designed. These opportunities are set forth in the course manual. If during the course the student satisfies all the effort requirements and does not receive a satisfactory grade but does receive a final grade of at least 4.00 before rounding, he or she will be given one opportunity to take a supplementary test. The specifics can be found in the Teaching and Examination Regulations and the course manuals.

Plagiarism, Code of Originality
Energy Science is a research oriented Master's programme, which means that its students are taught how to perform scientific research and which demands their approach and results need to meet. Since science is about developing new knowledge, in all phases of the Master's programme, much attention is paid to the originality of the students' achievements, for instance with the aid of advanced software. All scientific research, including that of a student, builds on the results of the work of other researchers, either in positive or in negative sense. Those other researchers deserve the credits for their work, in the form of a correct acknowledgement.
In short: quoting is allowed (and even necessary), but copying other researchers' work and presenting it as if it were one's own, is plagiarism: a huge sin in science, and therefore students have to sign a Statement of Originality when they submit the Master's thesis. Students, who plagiarise, run tremendous risks: in the worst case scenario they are expelled from the programme for a year. The Teaching and Examination Regulations of the programme lists the sanctions with which a student who is caught plagiarising will be confronted.

2.2 Study management and supervision

2.2.1 Introduction for new students

There will be an introduction for Master novices in the first week of their first semester, organised by ES and its study association NRG. Both social issues and general information will be presented during this introduction. Its objective is to help new students feel at home at the Master's programme ES and the faculty, as soon as possible. Focus will be on meeting your fellow students, getting to know the ES-programme itself, its professors, mutual rights and obligations, information desks and the buildings where you will spend much of your time in the next couple of years.

2.2.2 Study planning and advice

Two individuals play a key role in planning and supervising a student's study: the programme leader (dr. ir. Andrea Ramirez) and the Study Advisor, drs. Pieter Louwman.

The programme leader advises students on the programme they will be taking and on the choices that can be made within it. These choices pertain to elective courses and options for internships and thesis research, for instance. If you would like to receive advice first, you can contact the Study Advisor.

During your entire programme, you can go to the Study Advisor, Drs. Pieter Louwman, for neutral and confidential advice on everything that is related to your studies. This can be on issues that are directly study-related, for example study delay, electives, dissatisfaction with the programme, or a potential conflict with a teacher or supervisor. But you can also discuss more personal issues that might be of influence on your progress, such as illness, disability, pregnancy, family circumstances, top-class sports, motivation issues, et cetera. When necessary, the Study Advisor can refer you to a Student Counsellor, Student Psychologist, the Study Counselling Centre, or for example a study skills class.

In the unfortunate situation that you expect to suffer study delay due to personal circumstances, it is important to contact the Study Advisor as early as possible. Together you can discuss how you could deal with these circumstances and perhaps the programme could offer you a concession (e.g. extra time for an exam or paper).

The Study Advisor is located in the Koningsberger building, room 1.20E. For short questions you can drop-in without an appointment on Mondays and Wednesdays from

13.00 till 14.00. Outside these hours, or in case of more complex questions, an appointment is recommended. Feel free to take initiative to make such an appointment at the secretary's office (Van Unnik building, room 10.20) or by phone: 030 253 1625 or 030 253 2359.

The Study Advisor is a member of the Dutch National Society of Study Advisors and works according to the code of conduct of this professional society, see www.lvsa.nl for details.

The Study Advisor is in regular contact with other Study Advisors of the Faculty and University, which makes peer feedback and cooperation possible. If the Study Advisor is not available due to illness or holiday and you urgently need a confidential consult, please feel free to contact any of the other Study Advisors of the Faculty of Geosciences. You can find their contact details via the website of the Student Affairs office Geosciences (http://www.uu.nl/en/organisation/faculty-of-geosciences/contact-information/contact-information-for-students).

2.3 Course registration and automatic graduation

2.3.1 Semesters and blocks

Classes take place during two semesters, each of which can be divided into two blocks, or periods of 10 or 11 weeks. In Appendix III and IV you will find the start and end dates of each block for this academic year.

2.3.2 Timeslots

At Utrecht University a so-called timeslot model is used to schedule courses to fit into fixed parts of the week. Using this model prevents overlap in a schedule. In this way it is easy to see if two courses can be taken in the same period.

The Utrecht University timeslot model consists of five slots (A, B, C, D, E).

Timeslot A = Monday morning and Wednesday morning
Timeslot B = Tuesday morning and Thursday afternoon
Timeslot C = Monday afternoon and Thursday morning
Timeslot D = Wednesday afternoon and Friday
Timeslot E = Monday evening until Friday evening

Morning = 09.00-12.45 hours, afternoon = 13.15-19.00 hours, evening = 18.00-21.45 hours.

Periods and timeslots have been put into the course schedule (§1.9). Changes to the course schedule are still possible. The final scheduling (time and lecture room) of each courses will be made public via http://students.uu.nl/en/geo/energy-science/academics/schedules.

2.3.3 Course registration

In order to participate in a course, you need to be registered for it: if you are not, you will not have access to the course and its supporting facilities such as Blackboard; neither will results be registered. No registration = no participation = no result.

As a student, **course registration is your own responsibility**! You decide which courses (elective and mandatory) you want to take in each block. Keep in mind possible

entrance requirements to a course; students that do not adhere to entrance requirements cannot register for the course and/or will be removed from the course.

Course registration is **only possible via internet**, www.uu.nl/Osirisstudent and **only within the official registration periods**, which usually fall in the beginning of the previous block (for the dates of the Faculty of Geosciences, please see Appendix IV). You can register for no more than 2 courses (15 EC) of the Faculty of Geosciences per period (code GEO4-*). Students that register on time are generally secured of a place in the course; however, courses that have a limited capacity have certain placement rules. Just before the start of the block, there are 2 days for late registration, in case you want to switch courses. Please note: this is only possible for courses that are not full yet; participation is therefore not guaranteed.

If you want to register for a course outside the Faculty of Geosciences, there could be different registration dates; at some Faculties, students register only once per semester.

Each period (or block) you can register for a maximum of two courses (15 EC) of the Faculty of Geosciences via Osiris (code GEO4-*). Any student that wants to take a third course, needs permission of the programme. If the 3rd course is a course of one of the Master's programmes of the department of Innovation, Environmental and Energy Sciences (Innovation Sciences, Sustainable Development, Energy Science, Sustainable Business & Innovation or Water Science and Management; codes GEO4-22**, GEO4-23**, GEO4-25**, GEO4-26** and GEO4-60**), you can fill out a digital form on: https://fd8.formdesk.com/universiteitutrecht/additionalcourseGEO.

Please note:

- This registration form needs to be submitted during the regular registration period. During the late registration (na-inschrijving) it is no longer possible to apply for an additional course.
- You have to be enrolled for your other courses in Osiris before submitting your request for an additional course.
- The additional course should be a course from your own major programme/ department.
- Students are not allowed to participate in more than one course in the same timeslot.
- Enrolment in an additional course may be declined by the Director of Education in case of insufficient study progress and/or insufficient capacity for a course.

After the regular registration period and during late registration periods, no requests for taking a 3rd course will be dealt with and therefore they will always be denied. If the course is full, the request for a 3rd course will also be denied. Only as an exception and based on sufficiently important reasons will the programme allow a student to take three courses in one period.

A request for taking a 3rd course will need to address the criteria mentioned below and these will be checked:

- Motivation: what is the student's motivation?
- Circumstances: are there any special, personal circumstances?
- Urgency: is it, at this point in time, necessary that the student takes three courses at once?
- Feasibility: can the student handle taking three courses at the same time? The following issues will be looked at in order to check this criteria:
    - Study progress.
    - Study results so far.
    - Has the student taken three courses before and if so, were they all completed successfully?

- Is the Master's thesis one of the three courses the student wishes to take? If this is the case, the request will not be granted.
- Timeslot: if the 3rd course falls in the same timeslot as any of the other courses you will be taking, the request for a 3rd course will never be granted.

Students that do not adhere to the registration periods can only under very special circumstances be placed in a course after permission from the Board of Examiners, which can be reached via examencommissie.geo@uu.nl. Always give your student number when communicating with the Board of Examiners. The Board of Examiners (NOT the lecturer of the course) decides whether you have a valid reason for not registering during the registration periods. If the Board of Examiners decides you do not have a valid enough reason, you cannot attend a course and no course results will be registered.

In other words: register early, as early as possible, for the courses that you want to take in the next block! This also applies to obligatory courses!

2.3.4 Grade Point Average

The final Grade Point Average (GPA) is stated on the International Diploma Supplement, and represents your academic performance. The final GPA is the average figure from the results achieved within the course's examinations programme, weighted by course credits and expressed on a scale of 1 to 4 with two decimals.

The calculation of the final GPA works as follows:

- all applicable examinations achieved as part of the examination programme of the Master's degree, are converted into quality points;
- quality points are the applicable examination result times the number of course credits (EC) for the section in question;
- the total number of quality points achieved divided by the total number of course credits obtained (EC) gives the average examination result;
- the average examination result is converted into the final GPA as shown in the table below:

Dutch exam grades		Corresponding letter grades	Grade Points
From 8.60	to 10	A+	4
8.00	8.59	A	4
7.70	7.99	A-	3.7
7.40	7.69	B+	3.3
7.00	7.39	B	3
6.70	6.99	B-	2.7
6.40	6.69	C+	2,3
6.00	6.39	C	2
5.60	5.99	C-	1.7
5.40	5.59	D+	1.3
4.50	5.39	D	1
0	4.49	F	0

Students who want a statement showing their GPA ranking in comparison to the Energy Science graduate population, may send a request to the Board of Examiners, at least 2 months before the graduation date.

2.3.5 Automatic graduation

When you are due to finish your programme, you will receive a message from the student administration about your graduation. After it has been verified that you have fulfilled all requirements of your programme, the Board of Examiners will be asked to judge your file. Please note: in order to graduate, you need to have fulfilled all requirements: all grades are known and registered in Osiris, you have paid all tuition fees, hard copies of any earlier decisions taken by the Board of Examiners have been handed in to the Student Affairs office Geosciences (if applicable), the required number of copies of your thesis have been handed in at the IEES secretary's office and you have uploaded your thesis to Igitur (https://osiris.library.uu.nl/scrol2/index.html?ou=GEO). Under certain conditions, it is possible to postpone your graduation, see article 6.1.6 of the Teaching and Examination Regulations 2016/2017.

In order to actually receive your degree certificate or to pick it up at Student Affairs, you need to fill out an exam-registration form. If you want to attend a graduation ceremony, strict deadlines regarding registration and handing in of any documents will be maintained.

Automatic graduation does not mean you will be de-registered automatically from the programme. You will need to take care of this yourself and this cannot be done until you have received formal confirmation of your graduation from the Board of Examiners.

2.4 Study abroad

Studying abroad means broadening your horizon, meeting new people, exploring different cultures, and expanding your field of study. If you are interested in going abroad there are many possibilities. You can follow courses, do an internship or conduct research. Make use of what the university in general, but the Faculty of Geosciences in particular, has to offer you.

A lot to organise?!
Don't worry, just make sure to start planning your period abroad in time. Do you want to study abroad? Start via the International Office Online: http://students.uu.nl/en/academics/study-abroad.

Answer these questions:

- Where would you like to go to?
- What do you want to do?
- Does this university have an agreement with UU?
- Which courses would you like to attend?
- When would you like to go?

Once you have found an answer to these questions, contact your Study Advisor to connect your period abroad to your study plan in Utrecht.

After you have consulted with your Study Advisor, The International Office of Geosciences is there to guide your through the process. For all your practical questions, please contact international.geo@uu.nl or visit Student Affairs / International Office on the 1st floor of the Victor J. Koningsberger building. Open daily apart from Wednesdays from 10.30-11.30 and 12.30-14.30 hrs or by appointment.

Besides, please visit our study association EGEA (Ruppert Building), or visit http://www.egea.eu/entity/utrecht. EGEA members generally have a lot of experience with studying abroad. They can help you out with a lot of practical matters (such as housing, experiences and tips & tricks).

In October and November several orientation meetings take place organised by the International Office. For more information, look at the website of your programme at study abroad.

Practical matters
Once you've decided to study abroad, you can apply through the regular procedure. Please do keep in mind the deadlines for application! More information about how to apply and which deadline to bear in mind can be found on website: http://students.uu.nl/en/exchange-destinations (all partners). Select the faculty destinations on Geosciences. For the Faculty International Office website, please look at the website of your programme and study abroad.

Good to know
- Eligible for studying abroad during their master are all students with formal permission from their programme coordinator. To obtain permission please use the 'study plan for studying abroad' (available via: http://students.uu.nl/en/academics/study-abroad/step-2-application-at-uu).
- After your programme coordinator has signed the study plan, upload it in Osiris
- Credits obtained at partner universities can quite often easily be transferred to your academic record in Utrecht: study abroad doesn't necessarily cause delay in your programme!
- If your destination is within Europe, either for courses (exchange) or an internship, you are eligible for an ERASMUS grant. Monthly financial support to make your study abroad easier than it already is.
- If your destination is outside Europe, please have a look at www.beursopener.nl and find out if you are eligible for the options mentioned.
- If you're going abroad, you'd better put your OV student chip-card on hold (public transport card for Dutch students). By doing this, you can apply for a monthly travel allowance. Forms for this allowance are to be signed by the Student Affairs office/International Office.

2.5 Student Affairs Office Geosciences and Student Services

The *Student Affairs Office Geosciences* is the primary point of contact for students in the faculty of Geosciences. It provides students with general information and answers questions about registration for courses, course timetables, examinations, grades and credits, etc.

Student Affairs Office Geosciences is situated at the Victor J. Koningsberger building, Budapestlaan 4a-b, Tel: +31-30-253 9559.
Opening hours: Monday – Friday: 10.30-11.30h and 12.30-14.30h.
During academic holidays opening hours may be limited.
Internet: http://students.uu.nl/en/geo
E-mail: studentaffairs.geo@uu.nl

You can contact *Student Services* for information on a wide range of issues relating to studying and student life. This includes admission, application and enrolment, tuition fees, financial assistance, working alongside your studies, insurance, schemes and

facilities for outstanding student athletes, student housing and student organisations and information about studying with a disability or chronic illness.

If you have questions about your study programme, schedules, student progress review, examinations, exemptions, study abroad and your graduation: please contact the Student Affairs office Geosciences.

Contact details Student Services:
E-mail: studentservices@uu.nl (please mention your student number!)
Tel: + 31 30 253 7000 (Monday to Friday 10-12 am and 1-3 pm)
Fax: + 31 30 253 2627

Visitors' address: Heidelberglaan 6, De Uithof (Monday to Friday 10 am - 4 pm)

Postal address:

Student Services
Postbus 80125
3508 TC Utrecht
The Netherlands

For questions about ICT you can send an email to servicedesk@uu.nl.

2.6 Responsibility for the programme

Board of Studies
Within the Utrecht Graduate Division (UGD) the Master's programme Energy Science is part of the Graduate School of Geosciences, to which all Master students and PhD-students of the Faculty of Geosciences belong. The School supervises the quality of the programme and the admission of its students. All Directors of Education and Directors of Research of the Faculty of Geosciences are members of the Graduate Board of Studies, as well as a PhD student and a student from one of the MSc programmes of the Faculty. Chairman is the dean of the Faculty, prof. dr. Piet Hoekstra; the Board's secretary is mr. Diederik Gussekloo (d.gussekloo@uu.nl).

Master Education Committee
This is a joint committee of chosen students and lecturers appointed by the dean to advise on the Rules on Teaching and Examination and its implementation and about other matters concerning the study programmes. Its secretary is mrs. drs. Erika Dijksma (e.b.dijksma@uu.nl).

Board of Examiners
The Board of Examiners is responsible for the examination of students. The Board of Examiners will determine the examination results as soon as the student has submitted sufficient proof of the tests taken. This Board also decides about deviations (e.g. exemptions) in the programme and the approval of elective courses (see appendix I of this catalogue). Requests about exemptions or optional courses can be addressed to the secretary of the Board's chamber for Innovation, Environmental and Energy Sciences, mrs. drs. Erika Dijksma (examencommissie.geo@uu.nl).

Teaching Institute
The Teaching Institute Innovation, Environmental and Energy Sciences is responsible for the organisation, coordination and quality assurance of the educational elements of the various courses offered by the department. The Director of Education, dr. Margien Bootsma, is the Teaching Institute's head and is assisted by a management team, which includes the programme leaders of the Bachelor's and Master's programmes. The

programme's leader, dr. ir. Andrea Ramirez is responsible for the management of the programme Energy Science. She also deals with the daily matters in the Natural Science track. Daily matters in the Systems Analysis track are dealt with by dr. Wilfried van Sark.

2.7 Evaluation and quality assurance

The Faculty of Geosciences values the high quality of its programmes and has therefore set up a quality assurance system. Quality assurance provides information about the quality of individual courses and the programme as a whole, study climate and students' progress and performance. Its most important goals are improving education and organization, and increasing the visibility of the quality of the programme.

One part of quality assurance with which you as a student will be dealing regularly is evaluations. Every course is evaluated afterwards and the results of this *course evaluation* are discussed in the Education committee and the Management team of the programme. Evaluations provide important information for the course coordinator and lecturers to improve his/her course. All Geosciences students are allowed to view the evaluation results of the Faculty of Geosciences on Blackboard.

During the course, we also work on improving quality. *Course feedback groups* are active in each course in order to mend any problems in an early stage. For each course, such a group consists of 4-5 students who will be meeting the lecturer in the break and will be talking about the course so far. The purpose is to find out what is appreciated, what is going well and what practical issues can be improved. This does not concern aspects which are already fixed, such as the choice of literature, set up of tutorials or class times. It is all about fine-tuning, e.g. are the lecture slides readable, can everyone hear the lecturer, has information been put on Blackboard on time, etc. In the study guide of the course you can find further information about the course feedback group in your course.

Finally, at the end of each academic year (May/June) a written *year evaluation* will be carried out among the students. The year evaluation it is not about an individual course but about issues that transcend the course, such as coherence/set-up of the programme, electives, workload and effort, level, thesis supervision, challenge, atmosphere and lecturers.

The results of the year evaluation will be discussed in panel meetings with the education director, programme leaders and a student delegation.

2.8 Career Services

The start of your Master's programme will be the start of your career as well. Your Master's programme will prepare you very well for the labour market in the way of professional knowledge and skills. Career Services will support you by finding out which possible future is right for you.

As part of your Master's programme you will focus on labour market orientation such as company visits, guest lectures and meeting alumni. An internship will let you familiarise yourself with a company or organisation and will give you the experience of your first step on the labour market.
During your Master you can discover your talents, interests and motivation by following workshops and special training programmes, meeting with a career officer and attending career days organised by Career Services.

Check the website of your Master's programme under Career Services.
The career officer of the faculty of Geosciences is mrs. Franca Geerdes (f.geerdes@uu.nl).

2.9 MyUU App

The MyUU app contains your grades from OSIRIS and your course schedules. Apart from the full schedule it is also possible to add your own group schedule, as soon as you know which group you participate in.
The app is available for Android and iOS. Log in to the app using your Solis-id and password.

2.10 NRG, ES's study association

NRG is the study association for all Master's students in Energy Science. NRG was founded to support the contact and cooperation between its members, alumni, the University as well as companies and organisations linked to energy and sustainability. NRG organises an annual study trip (Germany in 2012 and 2015, Denmark in 2013 and France/Belgium in 2014), inspiring talks by professors and companies, excursions and NRG Drinks. Further, the association is involved in educational quality control by taking a seat in the faculty's educational committee. Follow us on Facebook, visit the website (nrg-utrecht.nl) or send us an email (info@nrg-utrecht.nl) to become a member.

3 Course descriptions

Note: in case of a discrepancy between the entrance requirements and/or recommended pre-requisites mentioned in this course catalogue and the ones mentioned in the electronic UU course offerings database 'Osiris', the entrance requirements and/or recommended pre-requisites mentioned in the table in § 1.10 are leading.

IS-Technology Related Venturing		
Code: GEO4-2268	**Credits: 7,5 EC**	**Level: M**
Programme	IS/SBI	
Status	Obligatory for IS and SBI; Elective for other programmes Required for the university wide Annotation 'Sustainable Entrepreneurship & Innovation'	
Period/Timeslot	1 C	
Language	English	
Coordinator	dr. J. Faber	
Instructor(s)	dr. J. Faber (j.faber1@uu.nl), dr. W.P.C. Boon (W.P.C.Boon@uu.nl)	
Open to other students	Yes	
Entry requirements		
Entry requirements	None	
Assumed previous knowledge	Organisation Theories (GEO2-2218), Management of Innovation Processes (GEO3-2221)	
Previous knowledge can be gained by	Reading the literature prescribed for Organisation Theories and Management of Innovation Processes.	
Course content		
Objectives	The objectives of this course are to make students aware of the opportunities and threats of developing innovations within established and entrepreneurial companies, to make them acquainted with theoretical concepts and models relevant for these subjects and to train their academic skills necessary for recognizing, analysing and managing innovation problems that emerge in practice from a theoretical perspective. After completion of the course, the student: • has advanced knowledge and understanding of the dynamics and challenges of Science and Innovation in the context of both organizations and society at large, • has insight into the complex interactions between science, innovative technology and society and is able to reflect critically upon the roles of science and technology in society; • is able to communicate conclusions, as well as the knowledge, reasons and considerations underlying these conclusions, to an audience of specialists and non-specialists.	

Content	Technology related venturing comprises activities of organizational entities (within established firms or as new enterprises), which are focused on developing and launching new, better and/or cheaper products, services or processes based on new technological insights into and knowledge of emerging technologies like biotechnology, clean technology (including sustainable energy and transportation technologies) and information technology. Ventures engaged in innovation will, however, face many problems arising in practice, which they have to deal with: lacking resources and complementary assets; lacking dynamic capabilities; the prevailing appropriation regime; the emergence of a dominant design and standardization; assessment of user needs and customer value; and competition. In this course, these problems are studied in further details with respect to their causes, possible solutions and management. Additionally, empirical cases from technological fields like biotechnology, clean technology and information technology will be analysed in order to provide students with the academic skills to apply theoretical knowledge for the solution of innovation problems encountered in practice by established as well as entrepreneurial firms. Academic and professional skills: *Concise writing, valuing literature, argumentation and reasoning, and reflection on science and society & Giving feedback and learning to work independently*.
Entry requirement for	This course is an entry requirement for: • Master's Thesis IS (GEO4-2239X) • Master's Thesis Internship SBI (GEO4-2606) • Consultancy Project IS (GEO4-2252) • Consultancy Project SBI (GEO4-2605)
Instructional modes	
Instructional modes	Lectures (Required); Group meetings (Required)
Class session preparation	See course manual
Contribution to group work	See course manual
Assessment	
Explanation	Written exam (50%), paper on the group assignment (40%) and participation in group meetings (10%)
Study materials	
Literature	List of scientific articles (see course manual)

SUSD-Policy Analysis		
Code: GEO4-2306	**Credits: 7,5 EC**	**Level: M**
Programme	SD/IS/SBI/ES	
Status	Obligatory for SUSD track ESG; elective for IS, SBI and ES	
Period/Timeslot	1 D	
Language	English	
Coordinator	dr. H.L.P. Mees	
Instructor(s)	Dr. C. Dieperink, dr. H.L.P. Mees, dr. H.A.C. Runhaar	
Open to other students	Yes, however: **Maximum 60 participants. Students for whom this course is obligatory have priority.**	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Innovation Sciences, Sustainable Development, Energy Science, Sustainable Business and Innovation	
Course content		
Objectives	After completion of the course, students should: • Be able to characterise various methods of policy analysis; • Be able to combine and apply concepts, methods, and criteria from policy analysis theory in specific policy situations; • Have insight into the role of the policy analyst in the policy process. The emphasis will be on the second course objective. **Maximum 60 participants. Students for whom this course is obligatory have priority**	
Content	Policy analysis involves a wide variety of activities related to the study of public policy, which can be defined as "political agreement on a course of action (or inaction) designed to resolve or mitigate problems on the political agenda – economic, social, environmental and so on". Within the field of policy analysis uusally distinction is made between analysis of policy and analysis for policy. The primary goal of research in the field of analysis of policy is to develop a better understanding of public policy and the policy-making process. Analysis for policy is usually defined as "the use of analytical techniques and knowledge for and in policy-making". The aim of policy analysis in this meaning is to support policy-makers, by producing and transforming 'policy-relevant information'. This course will focus on analysis of policy. Students will acquire both theoretical knowledge and practical skills concerning several methods of policy analysis, including: • Reconstruction of policy theory • Impact Assessment • Cost-Benefit Analysis and Cost Effectiveness Analysis • Discourse analysis	
Entry requirement for	Students must have actively participated in this course in order to take Research Methods ESG (GEO4-2304) and International Governance for SD (GEO4-2305) and Analysing Governance Practices (GEO4-2328).	

Instructional modes	
Instructional modes	Lecture Tutorial (Required)
General remarks	Lecture: Guest lectures and tutorials are compulsory.
Assessment	
Explanation	The final mark will be based on the average of several assignments.
Study materials	
Literature	Required: Study guide: Course manual Literature: Supplementary literature (articles etc.)

SUSD-Policies for Energy & Materials Transitions		
Code: GEO4-2311	**Credits: 7,5 EC**	**Level: M**
Programme	SD/IS/SBI/ES/Earth Science	
Status	Obligatory for SUSD track E&M; Elective for IS, SBI, Energy Science and Earth Science	
Period/Timeslot	4 B	
Language	English	
Coordinator	dr. R. Harmsen	
Instructor(s)	dr. J.C.M. Farla, dr. R. Harmsen	
Open to other students	Yes	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Earth, Life and Climate, Energy Science, Earth Structure and Dynamics, Earth Surface and Water, Innovation Sciences, Sustainable Business and Innovation, Sustainable Development	
Assumed previous knowledge	Basic quantitative skills for analysing the energy and materials system.	
Previous knowledge can be gained by	Following the course GEO4-2326 (Tools for Energy & Materials Analysis) or equivalent	
Course content		
Objectives	After completion of this course, the student is able to: • apply and synthesize theoretical models on the dynamics of energy & material transition processes; • analyse and evaluate current policy practices related to the transformation of the energy & materials system; • analyse barriers & drivers for innovative and sustainable energy technology deployment; • analyse the various steps of the policy cycle • analyse and evaluate current energy & materials policy targets & instruments in terms of effectiveness (environmental impact) and coherency (accounting for policy interaction); • apply and analyse the three building blocks of policy/program theory: impact theory, service utilization plan and organizational plan.	
Content	In this course we make a distinction between two policy perspectives on the energy system. Both perspectives share the underlying notion that the energy system needs to change in order to become more sustainable. The first perspective (part 1 of the course) focuses on the dynamics of these systemic change processes. This involves insight in sustainable energy innovation processes and factors that influence the transformation of the energy system. We label this view as the "Energy Transition Perspective". The second perspective (part 2 of the course) is concerned with the impact of the energy system on issues like climate change, energy security, employment, local air quality and national interests of governments (e.g. regarding national energy and material reserves) and industry, and aims to design policy instruments that push or pull the energy system in the desired direction.	

	Both views are strongly related and should be well aligned for optimal policy outcomes, however in reality they are quite far apart. The challenge for policy makers is to develop consistent and well aligned policy instruments that contribute to meeting targets, ambitions and agreements embedded in the policies. The challenge for firms and entrepreneurs in the energy system is to develop smart strategies in response to these policies. Academic skills: • *Communicative skills (writing, presentation, discussions and argumentation).* • *Social and organizational skills (working together, functioning in a team and planning your own work and time).* • *Literature research (analysing and using literature).* • *Self-reviewing (reflect on your own knowledge and skills).*
Entry requirement for	This course is an entry requirement for: N/A
Instructional modes	
Instructional modes	Lecture (Required) Presentation (Required) Tutorial (Required)
General remarks	Lecture: The course setup of part 1 includes two tutorials per week (2 hours each). In part 2 of the course one (guest)lecture + one tutorial per week are provided. Tutorial: Both in part 1 and part 2 of the course students need to work on assignments, both individually and in groups.
Class session preparation	Tutorial: Part 1 tutorials need to be prepared in advance. Preparation includes the reading of scientific literature and the answering of assignment questions.
Contribution to group work	Tutorial: Students are expected to make a balanced contribution to group work. Free-riding is not accepted.
Assessment	
Explanation	Assignments, presentation
Study materials	
Literature	Required: Items: Journal articles, book chapters and lecture slides as indicated in the course manual or assignments

SUSD-Environmental Ethics & Sustainable Development		
Code: GEO4-2323	**Credits: 7,5 EC**	**Level: M**
Programme	SD/IS/WSM/ES/SBI	
Status	Elective	
Period/Timeslot	1 A	
Language	English	
Coordinator	dr. F. van den Berg	
Instructor(s)	dr. F. van den Berg	
Open to other students	Yes	
Entry requirements		
Entry requirements	None	
Course content		
Objectives	After completion of the course, the student is able to: • describe the philosophical dimensions of sustainable development; • perform an in-depth analysis of the concepts 'sustainability' and 'development'; • give an overview of contemporary environmental ethics; • perform an integral and critical assessment of moral stances on environmental problems and sustainable development; • write an article for a general audience on environmental issues, using philosophical tools & knowledge.	
Content	The present-day political and economic systems are not sustainable and we are heading for global environmental disasters (ecocide). The notions 'sustainability', 'development' and 'sustainable development' have gradually entered political and social debates, and scientific and philosophical investigations. It is rooted in concern about environmental degradation of our planet. Philosophical reflection about sustainable development and the human-nature relationship starts with clarifying key concepts of environmental science. Sustainable development should at least encompass three dimensions: (1) the environment (conservation and preservation), (2) economy (growth vs. steady state), and (3) the social structure (equity, welfare). These dimensions form the pillars of sustainable development and will be studied from a philosophical viewpoint.. This course aims at providing philosophical reflection on sustainable development-related issues as part of environmental philosophy. We start with reflection on three kinds of relationships from the perspective of sustainability: humans-humans, humans-animals, and humans-nature. During the course key concepts and methods of environmental philosophy are dealt with. We will explore concepts such as biodiversity and vulnerability, demographic transition and inter- and intragenerational (environmental) justice. The emphasis of the course is normative deliberation on the environmental crises and sustainable development. What insights can science and environmental philosophy give to sustain life, future generations and a healthy ecosystem of planet Earth?	
Entry requirement for	This course is the entry requirement for: N/A	

Instructional modes	
Instructional modes	Lectures (Required) Seminars (Required) Excursion, a walk in the woods (Required)
Assessment	
Explanation	4 columns (500-600 words), 4 newspaper comments (200-300 words), , 1 paper (2500-3000 words)
Study materials	
Literature	Required: Book: Curry, Patrick, *Ecological Ethics* Book: Berg, Floris van den, *Philosophy for a Better World*. Book: Oreskes, Naomi; Conway, Erik, *The Collapse of Western Civilization* Book: Callenbach, Ernest, *Ecotopia*.

SUSD-Fossil Resources: past, present and future		
Code: GEO4-2325	**Credits: 7,5 EC**	**Level: M**
Programme	SD/SBI/ES/Earth Sciences	
Status	Elective for SD track E&M, SBI, ES and Earth Sciences	
Period/Timeslot	3 A	
Language	English	
Coordinator	dr. P.K. Bijl	
Instructor(s)	Guest lecturers from UU Earth Sciences and TNO	
Open to other students	Yes	
Remarks	**Master's students in Earth Sciences cannot take this course if they have taken or are going to take any of the following courses: GEO4-1441, GEO4-1517A, GEO4-1425 and GEO4-1437**	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Earth, Life and Climate, Energy Science, Earth Structure and Dynamics, Earth Surface and Water, Sustainable Business and Innovation, Sustainable Development	
Course content		
Objectives	After completion of the course, the student: • has obtained an in-depth understanding of the various concepts and techniques applied to predict the origin and distribution of hydrocarbons in the subsurface; • is capable of evaluating the present-day status of hydrocarbon exploration and exploitation with an eye on future developments; • has developed practical skills to interpret hydrocarbon plays; • shows an academic, professional and critical attitude towards environmental and/or social impacts of fossil resources and is able to formulate this opinion in an academic report.	
Content	This course focuses on the basics of the geology and geophysics for oil- and gas-exploration and production, the historical, economical and societal aspects of petroleum science and the new developments within the industry for future exploration of fossil resources (including geothermal energy, shale gas, oil enhanced recovery). Aspects covered include requirements for finding and producing oil or gas, societal consequences of petroleum production, future endeavours and consequences. *Part 1 Past:* • Geological parameters of petroleum systems (deposition, trap, charge, reservoir) • Studying the subsurface: time and space *Part 2 Present:* • Current exploration and exploitation of hydrocarbons • Environmental impacts and solutions (incl. technological developments and health, safety and environmental management)	

	• Using empty reservoirs for storage of CO2 (CCS; chances and risks) *Part 3 Future:* • Unconventionals: coal bed methane, tight gas and shale gas • Alternatives: geothermal energy Academic skills: • Problem solving ability • Ability to integrate knowledge • Presentation skills • Team / interpersonal skills
Entry requirement for	This course is an entry requirement for: N/A
Instructional modes	
Instructional modes	Lecture; Practical (Required)
General remarks	Most weeks, there will be a mix of lectures and class assignments (practicals) on both Monday and Wednesday. However, depending on the guest lecturer, the actual learning activities might change, but not outside the planned hours. Practical reports made by teams of two students
Assessment	
Explanation	Written exam, assignments (practical reports) and oral presentation. Weighing will be outlined in the course manual.
Study materials	
Literature	Required: Course manual: Key papers to be announced in class

SUSD-Climate System and Adaptation		
Code: GEO4-2327	**Credits: 7,5 EC**	**Level: M**
Programme	SD/IS/ES/SBI/Earth Sciences (MSc Science Communication on request)	
Status	Elective	
Period/Timeslot	2 B	
Language	English	
Coordinator	prof. dr. H. Middelkoop	
Instructor(s)	prof. dr. H. Middelkoop	
Open to other students	Yes	
Remarks	**Students who are registered for the programme Science Education and Communication please contact the Board of Examiners before enrolment in Osiris (examencommissie.geo@uu.nl).** **The course is not recommended for Earth Sciences MSc students who have done similar courses in the ESW programme.**	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Earth, Life and Climate, Energy Science, Earth Structure and Dynamics, Earth Surface and Water, Innovation Sciences, Sustainable Business and Innovation, Sustainable Development, Science Education and Communication	
Resources for self study	IPCC AR5 reports 2013-2014	
Course content		
Objectives	Effective adaptation to climate change requires an in depth knowledge of the climate system itself as well as its detrimental effects on our living environment. This course thus focuses on climate adaptation strategies, after treatment of the various components of the climate system, important feedbacks and impacts. After completion of the course the student: • has knowledge and understanding of the climate system, climate forcings and important feedback mechanisms, over a range of time scales from glacial cycles to the past century; • has knowledge and understanding of the mechanisms and drivers of the future climate, the role of humans and climate scenarios for impacts studies; • understands why and how climate has impact on the functioning of rivers, coasts, agriculture, and urban environments; • has understanding of the types and causes of uncertainty associated with climate adaptation; • knows main principles of prevention, mitigation and adaptation strategies; • understands currently available options for adaptation and can apply these to various different domains.	
Content	***Understanding the climate system (4 weeks)*** • Components of the climate system • Climate forcings over different time scales • Future climate and climate scenarios	

	• Feedbacks: water and carbon • Feedbacks: carbon and nutrients. ***Climate impacts (2 weeks)*** • Rivers • Coastal zone, including the coastal lowlands • Urban environment • Dryland agriculture. ***Adaptation Strategies (2 weeks)*** • Uncertainties • Resilience and resistance • Adaptation strategies • Policy options and perspectives Academic skills: *Literature analysis; presenting; writing; evaluation and application of climate adaptation options and strategies*
Entry requirement for	This course is an entry requirement for: N/A
Instructional modes	
Instructional modes	Computer practical (Required) Lecture (Required) Presentation (Required)
General remarks	Lectures, Practicals (scenarios, management strategies), Paper peer-review, Presentations, Short paper writing. Lectures and practicals are mandatory.
Assessment	
Explanation	Grading based on hand-in practical assignments, presentations and short paper, mid-term test on the climate system, and final exam.
Study materials	
Literature	Required: Literature: Lecture handouts plus papers, distributed through blackboard system. Literature: Houghton, J.T. (2015) Global Warming – The complete briefing. 5th Edition. Cambridge University press..

ENSM-Energy Conversion Technologies I (thermal/chemical)		
Code: GEO4-2502	**Credits: 7,5 EC**	**Level: M**
Programme	ES	
Status	Obligatory	
Period/Timeslot	1 C	
Language	English	
Coordinator	dr. E. Nieuwlaar	
Instructor(s)	dr. H.M. Junginger, dr. E. Nieuwlaar, dr. ir. C.A. Ramirez	
Open to other students	Yes	
Entry requirements		
Entry requirements	None	
Assumed previous knowledge	Knowledge of Elementary thermodynamics and calculus	
Previous knowledge can be gained by	Studying the first 7 chapters of the book by Çengel/Boles (see materials)	
Resources for self study	book by Çengel/Boles (see materials)	
Course content		
Objectives	After completion of this course students will be able to perform thorough analyses of thermal and chemical energy conversion technologies and systems on the basis of scientific principles that underlie these technologies. The technologies covered are: 1. Power cycles (steam turbines, gas turbines, Otto, Diesel, etc.) 2. Fuel cells 3. Electric/hybrid vehicle technologies 4. Heat transfer (heat exchangers, heat pumps, refrigeration) 5. Biomass production & conversion 6. Thermochemical conversions (combustion, gasification, …) 7. Carbon dioxide Capture & Storage 8. Hydrogen technologies	
Content	The relation between design of energy conversion systems and their performance is the core of this course. In order to investigate this relation you need to open up the "black box" of energy conversion systems. Instead of characterizing a system by inputs and outputs, as is done in many other courses, you need to study the scientific principles on which the system is based, and which lead, in the end, after having closed the black box, to the system-specific inputs and outputs. Applying basic principles will allow you to define maximum theoretical conversion efficiencies, and comparing these to actual efficiencies shows that many improvements (still) are possible. This course is subdivided in three parts: basics, examples of thermal and chemical energy conversion technologies, and one detailed energy conversion technology case. In the basics part general thermodynamic principles common to energy conversion technologies are treated.	

	The conversion technologies covered include • Refrigeration and heat pumps • heat exchangers • Gas and steam turbines • Diesel and Otto engines • Fuel cells • Biomass production and conversions • Thermochemical conversions (combustion, gasification, …) • Carbon dioxide capture and storage. • Hydrogen technologies A case study will be performed by the students, and these will be presented to other students in a mini-symposium. These case studies are based on recent literature. **Note** The course Energy Conversion Technologies – II concentrates on physical and mechanical energy conversions. Together, they constitute a wide overview of energy conversion technologies. Academic skills: *presentation*
Entry requirement for	This course is an entry requirement for: • Master's thesis (GEO4-2510) • Natural Science Research Project (GEO4-2518) • Internship Energy Science (GEO4-2520)
Instructional modes	
Instructional modes	Exercise classes and computer practicals (Required) Lectures (Required) Project work (Required) Mini-Symposium (Required)
General remarks	Exercise classes and computer practicals: The energy conversion technologies are treated in 2 hour lectures, introducing concepts, theory and applications, followed by 2 hour exercise or computer class where the knowledge obtained is applied by making exercises. Project work: Analysis of recent review paper/article Mini-Symposium: Mini-Symposium on Energy Conversion Technology topics. In a minisymposium you present the state of the art regarding an energy conversion technology.
Class session preparation	Exercise classes and computer practicals: For useful participation in the exercise and computer classes the indicated material is to be studied along with participation in the lecture. Mini-Symposium: For the minisymposium you study a recent review article or report on the chosen energy conversion technology and you make a presentation for your fellow students.
Assessment	
Explanation	Two exams (both 40%) and a presentation during the mini-symposium (20%)
Study materials	

Literature	Required: Reader: Course reader, Lecture notes Literature: Thermodynamics, an engineering approach, 8th Edition in SI Units, by Y.A. Çengel and M.A. Boles (McGraw-Hill, 2014). The 7th edition can also be used. Literature: Renewable Energy Resources, 3rd edition, by J. Twidell, T. Weir (Routledge: 2015, ISBN 978 0-415-58438-8)

ENSM-Energy Conversion Technologies II (physical/mechanical)		
Code: GEO4-2503	**Credits: 7.5 EC**	**Level: M**
Programme	ES	
Status	Obligatory	
Period/Timeslot	2 A	
Language	English	
Coordinator	dr. W.G.J.H.M. van Sark	
Instructor(s)	dr. W.G.J.H.M. van Sark	
Open to other students	Yes	
Entry requirements		
Entry requirements	None	
Assumed previous knowledge	Knowledge of Elementary thermodynamics and calculus	
Course content		
Objectives	After completion of this course students will be able to perform thorough analyses of physical and mechanical energy conversion technologies and systems on the basis of scientific principles that underlie these technologies. The technologies covered are: 1. Solar energy conversions (thermal, photovoltaics) 2. Wind energy 3. Hydropower 4. Geothermal energy and Ocean Thermal Energy conversion 5. Saline power 6. Tidal and wave power 7. Nuclear fission and fusion	
Content	The relation between design of energy conversion systems and their performance is the core of this course. In order to investigate this relation you need to open up the "black box" of energy conversion systems. Instead of characterizing a system by inputs and outputs, as is done in many other courses, you need to study the scientific principles on which the system is based, and which lead, in the end, after having closed the black box, to the system-specific inputs and outputs. Applying basic principles will allow you to define maximum theoretical conversion efficiencies, and comparing these to actual efficiencies shows that many improvements (still) are possible. This course is subdivided in three parts: solar energy based energy conversion technologies, other technologies such as wind, nuclear, geothermal, hydropower conversion, one detailed energy conversion technology case. The case study will be performed by the students, and these will be presented to other students in a Minisymposium. These case studies are based on recent literature. **Note** The course Energy Conversion Technologies – I concentrates on thermal and chemical energy conversions. Together, they constitute a wide overview of energy conversion technologies.	

	Academic skills: *presentation*
Entry requirement for	This course is an entry requirement for (if applicable and not mentioned above): • Master's thesis (GEO4-2510) • Natural Science Research Project (GEO4-2518) • Internship Energy Science (GEO4-2520)
Instructional modes	
Instructional modes	Computer practical (Required) Lecture (Required) Tutorial (Required)
Assessment	
Explanation	The grade is based on one intermediate exam, one final exam, and the presentation on a recent paper during the mini symposium.
Study materials	
Literature	Required: Reader: Course reader Dictation: Lecture notes, handouts Book: Renewable Energy Resources, 3rd edition, by J. Twidell, T. Weir (Taylor and Francis: 2015, ISBN 978 0-415-58438-8) Book: B. Malmfors et al., Writing and Presenting Scientific Papers. Nottingham: UP, 2004 (2nd edition).

ENSM-Advanced Energy Analysis		
Code: GEO4-2508	**Credits: 7,5 EC**	**Level: M**
Programme	ES	
Status	Obligatory	
Period/Timeslot	2 D	
Language	English	
Coordinator	dr. E. Nieuwlaar	
Instructor(s)	dr. H.M. Junginger, dr. E. Nieuwlaar, dr. ir. C.A. Ramirez	
Open to other students	Yes	
Entry requirements		
Entry requirements	None	
Assumed previous knowledge	Knowledge of Energy Analysis and calculus	
Previous knowledge can be gained by	Energy Analysis (GEO3-2223)	
Resources for self study	Kornelis Blok, Introduction to Energy Analysis. Techne Press 2007. or the second edition: Kornelis Blok and Evert Nieuwlaar, Introduction to Energy Analysis, 2nd Edition. Routledge, 2016.	
Course content		
Objectives	After completion of this course students • have insight in the most important research methods for energy science and are able to apply them themselves. • have insight in the strong and weak points of these research methods and understand the level of uncertainties in using them. • can apply these research methods to analyse and evaluate options in the field of energy science.	
Content	This course covers: • Understanding and using the concept of technological learning for analyzing and predicting the development and performance of technologies over time • Process analysis by setting up energy and mass balances and performance calculations of complex technologies, using principles from Life Cycle Assessment and process technology. • Economic analyses of technologies and systems, using knowledge from cost engineering. • Proper use of energy and other statistics for comparing and analyzing performance of e.g. economic sectors. • Using Input/Output analysis as a tool to evaluate impacts on a national economy, e.g. impacts on GDP and employment generated by deploying different technologies • Using life cycle assessment to analyse and evaluate the environmental performance of energy technologies.	

	• Using (simple) Multi-Criteria Analysis as a system to combine very different types of information to provide an integrated evaluation
Entry requirement for	This course is an entry requirement for: • Internship Energy Science (SA) (GEO4-2509) • Master's thesis (GEO4-2510) • Research Project SA (GEO4-2510) (old cohorts) • Energy Science Research NS (GEO4-2512) (old cohorts) • Natural Science Research Project (GEO4-2518) • Internship Energy Science (GEO4-2520)
Instructional modes	
Instructional modes	Computer practical (Required) Lecture/tutorial (Required)
General remarks	Computer practical: During the computer practical supervision on your work is available. In the second part you work individually on a comprehensive assignment covering all research methods. Lecture/tutorial: In the first part each week starts with an introduction to one of the research method (lecture) followed by working in couples on an assignment where you learn to understand and apply the research method.
Class session preparation	Computer practical: You are expected to prepare the assignment before the weekly computer practical.
Assessment	
Explanation	Assignment for each research method (together 50%): Peer review and grading by staff and students. Final assignment (individual) covering all methods (50%).
Study materials	
Literature	Required: Course reader

ENSM-Internship Energy Science SA		
Code: GEO4-2509	**Credits: 18,75 EC**	**Level: M**
Programme	ES	
Status	Obligatory for track SA, and only open to students that started in 2012-2013 or earlier	
Period/Timeslot	N/A	
Language	English	
Coordinator	dr. ir. C.A. Ramirez	
Instructor(s)	dr. ir. C.A. Ramirez	
Open to other students	No	
Remarks	**This course is only open to students who started in 2012-13 or earlier, track Systems Analysis. Students who started on or after 01-09-2013 should register for GEO4-2520.**	
Entry requirements		
Entry requirements	Students must be registered for the following degree programme: Energy Science. Number of credits achieved: 45 EC of the Master's programme. One of the following courses must be completed: - ENSM-Advanced Energy Analysis (GEO4-2508) - Advanced Energy Analysis (AS-ES410M)	
Assumed previous knowledge	Consultancy project (GEO4-2501 or GEO4-2519)	
Course content		
Objectives	The main aim of the internship is to train students working in a professional organization that is active in the field of energy and materials.	
Content	The internship should be carried out in a professional organization outside the university where you can expect career opportunities. Examples are private companies, consultancies, governmental institutions, NGOs etc.. During the internship you should carry out one single project that results in a report supported by the hosting organization and the university. The internship project should contribute to solving a problem in the field of energy, climate and materials and it must be relevant for policy or management. The internship can be combined with the Master's thesis. The student delivers two outputs: an internship report an oral presentation Academic skills: *writing a report, presentation*	
Entry requirement for	This course is an entry requirement for: N/A	
Instructional modes		
Instructional modes	Individual supervision (Required)	
Assessment		
Explanation	Practical work (70%), report (20%) and presentation (10%)	
Study materials		
Literature	To be decided on an individual basis	

ENSM-Master's Thesis		
Code: GEO4-2510	**Credits: 30 EC**	**Level: M**
Programme	ES	
Status	Obligatory	
Period/Timeslot	N/A	
Language	English	
Coordinator	dr. C.A. Ramirez	
Instructor(s)	dr. C.A. Ramirez	
Open to other students	No	
Remarks	**Cohort 2012 and earlier (SA track) takes this course as Research Project SA for 30 EC or 37,5 EC. Cohort 2013 and later (SA and NS track) takes this course as Master's thesis for 30 EC.**	
Entry requirements		
Entry requirements	Students must be registered for the following degree programme: Energy Science. Number of credits achieved: 45 EC of the Master's programme. The following course must be successfully completed: - ENSM-Advanced Energy Analysis (GEO4-2508) And at least three of the following courses must be successfully completed: - ENSM-Energy in the Context of Sustainability (GEO4-2514) - ENSM-Energy Systems Modelling (GEO4-2515) - ENSM-Energy Conversion Technologies I (GEO4-2502) - ENSM-Energy conversion Technologies II (GEO4-2503)	
Assumed previous knowledge	Consultancy Project (GEO4-2519)	
Course content		
Objectives	The main aim of the master's thesis is to train students in independently conducting research in the energy science field.	
Content	The Master's thesis is a research project in which the student will learn to conduct research independently in the field of energy and materials, whereby new methods are developed and/or applied or existing methods are applied to a new problem. The research should be relevant from both a scientific point of view (it should expand the body of scientific knowledge) and a societal point of view (it should produce knowledge that can contribute to a better understanding or the solution of societal problems in the area of energy). The student delivers the following outputs: • Master's thesis proposal. The proposal should be handed in within four weeks after starting the Master's thesis. In this proposal the student should be able to translate a research question into a research plan that includes a justification of the problem, research question(s), methodology to be used, expected results and a time plan. The proposal should be approved by the supervisor before submission to the Board of Examiners. • Thesis. The Master's thesis is written in English. The student is encouraged to write the thesis in the form of a scientific article that is suitable for publication in a refereed journal. • Oral presentation. The purpose is to elaborate on the project for a scientific audience. The student should be able to extract key insights and lessons from the research work and present them to an audience of peers in an	

	adequate manner Academic skills: *academic writing, presentation*
Entry requirement for	This course is an entry requirement for: N/A
Instructional modes	
Instructional modes	Individual (Required)
General remarks	Frequency and type of supervision should be specified in the research proposal.
Assessment	
Explanation	Research proposal, Thesis content (70%), Presentation (10%), Process (20%), attending at least ten other students' presentations. The grade for the thesis content must be at least 5.50.
Study materials	
Literature	To be decided on an individual basis.

ENSM-Natural Science Research Project		
Code: GEO4-2511	**Credits: 22,5 EC**	**Level: M**
Programme	ES	
Status	Obligatory track NS, only for students that started in 2012-13 or earlier	
Period/Timeslot	N/A	
Language	English	
Coordinator	dr. W.G.J.H.M. van Sark	
Instructor(s)	dr. W.G.J.H.M. van Sark	
Open to other students	No	
Remarks	**Only open to students that started in 2012-13 or earlier, track Natural Science. Students who started on or after 01-09-2013 should register for GEO4-2518**.	
Entry requirements		
Entry requirements	Students must be registered for the following degree programme: Energy Science. Number of credits achieved: 45 EC of the Master's programme. At least two of the following courses must be completed: - Synthesis of Complex Nanostructures (SK-MSYNA) - Solids and Surfaces (SK-MSOLS) - Adsorption, Kinetics and Catalysis (SK-MAKC) - Device physics (NS-NM426M) - ENSM- Photovoltaic Solar Energy Physics and Technology (GEO4-2513)	
Course content		
Objectives	The main aim of the Research in the Science Faculty to train students in independently conducting research in the energy science related natural science field.	
Content	The Natural Science Research course is a research project in which the student will learn to conduct research independently in the field of energy-related natural science. The research should be relevant from both a scientific point of view (it should expand the body of scientific knowledge) and a societal point of view (it should produce knowledge that can contribute to addressing energy-related problems in society). The student delivers two outputs: • Thesis. A thesis is written in English. The student is encouraged to write the thesis in the form of a scientific article that is suitable for publication in a refereed journal. • Oral presentation. The purpose is to elaborate on the project for a scientific audience. This can take the form of a presentation for the colleagues in the department or attendees at a scientific conference. Academic skills: *writing a report, presentation*	
Entry requirement for	This course is an entry requirement for: N/A	
Instructional modes		
Instructional	Individual (Required)	

modes	Presentation (Required)
General remarks	Individual supervision
Assessment	
Explanation	Report (70%), process (20%) and presentation (10%)
Study materials	
Literature	To be decided on an individual basis.

ENSM-Energy Science Research		
Code: GEO4-2512	**Credits: 22,5 EC**	**Level: M**
Programme	ES	
Status	Obligatory track NS, only for students that started in 2012-13 or earlier	
Period/Timeslot	N/A	
Language	English	
Coordinator	dr. W.G.J.H.M. van Sark	
Instructor(s)	dr. W.G.J.H.M. van Sark	
Open to other students	No	
Remarks	**Obligatory for and only open to students that started in 2012-13 or earlier, Natural Science track. Students who started on or after 01-09-2013 should register for GEO4-2510 (Master's thesis)**.	
Entry requirements		
Entry requirements	Students must be registered for the following degree programme: Energy Science. Number of credits achieved: 45 EC of the Master's programme. One of the following courses must be completed: - ENSM-Advanced Energy Analysis (GEO4-2508) - Advanced Energy Analysis (AS-ES410M) and at least two of the following courses must be completed: - Synthesis of Complex Nanostructures (SK-MSYNA) - Solids and Surfaces (SK-MSOLS) - Adsorption, Kinetics and Catalysis (SK-MAKC) - Device physics (NS-NM426M) - ENSM- Photovoltaic Solar Energy Physics and Technology (GEO4-2513)	
Course content		
Objectives	The main aim of the energy science research is to train students in independently conducting research in the energy science field.	
Content	The Energy Science Research project is the final project in which the student will learn to conduct research independently in the field of energy science, whereby new methods are developed and/or applied or existing methods are applied to a new problem. The research should be relevant from both an energy science point of view (it should expand the body of scientific knowledge) and a societal point of view (it should produce knowledge that can contribute to a better understanding or the solution of a problem). The student delivers two outputs: • Thesis. A thesis is written in English. The student is encouraged to write the thesis in the form of a scientific article that is suitable for publication in a refereed journal. • Oral presentation. The purpose is to elaborate on the project for a scientific audience. This can take the form of a presentation for the colleagues in the department or attendees at a scientific conference. Academic skills: *writing a thesis, presentation*	
Entry requirement for	This course is an entry requirement for: N/A	

Instructional modes	
Instructional modes	Individual supervision (Required)
Assessment	
Explanation	Research proposal, Report content (70%), Presentation (10%), Process (20%), attending at least ten other students' presentations. The grade for the report content must be at least 5.50.
Study materials	
Literature	To be decided on an individual basis.

ENSM- Photovoltaic Solar Energy Physics and Technology		
Code: GEO4-2513	**Credits: 7,5 EC**	**Level: M**
Programme	ES	
Status	Elective	
Period/Timeslot	4 A	
Language	English	
Coordinator	dr. W.G.J.H.M. van Sark	
Instructor(s)	dr. W.G.J.H.M. van Sark, A. Louwen, MSc	
Open to other students	Yes	
Entry requirements		
Entry requirements	None	
Assumed previous knowledge	Basic knowledge of solid state physics or condensed matter physics	
Course content		
Objectives	Students will gain knowledge about solar cell physics, technology and applications and will thus be able to better appreciate the rapid developments in photovoltaic solar energy. The course offers insight in solar cell physics and technology by addressing semiconductor physics and operation of basic p-n solar cell devices, as well as frequently used processing methods, preparation and operation of wafer based and thin film solar cells. It also offers new developments in this field focusing on the application of nanotechnology.	
Content	The following topics will be covered: 1. Basic physics of semiconductors 2. Metal-semiconductor interfaces (Schottky barriers and ohmic contacts) 3. p-n junctions (including applications in devices such as solar cells and LEDs) 4. Semiconductor processing (chemical and physical deposition, etching, oxidation) 5. Thin film solar cells, including tandem cells 6. Selected other semiconductor materials and devices and new development 7. Solar cell performance 8. Experience solar cell research in practice by laboratory visit Academic skills: *writing a paper, presentation*	
Entry requirement for	This course is an entry requirement for: • Natural Science Research NS (GEO4-2511) • Energy Science Research NS (GEO4-2512)	
Instructional modes		
Instructional modes	Excercise class (Required) Lecture (Required)	
Assessment		
Explanation	Attendance required at least 75% of all contact hours.	

	Final result:20% exercise solving task, 40% short midterm paper, 40% final presentation
Study materials	
Literature	Required: The book: J. Nelson, The physics of solar cells", Cambridge University Press. ISBN: 978-1-86094-349-2 (soft cover) will be replaced, please contact the coordinator. Sheets: Lecture slides Reader: Other material on topics not covered in the book will be provided in reader.

ENSM-Energy in the Context of Sustainability		
Code: GEO4-2514	**Credits: 7,5 EC**	**Level: M**
Programme	ES	
Status	Obligatory	
Period/Timeslot	1 A	
Language	English	
Coordinator	dr. C.A. Ramirez and dr. W. Liu	
Instructor(s)	dr. C.A. Ramirez, dr. W. Liu, dr. M. van den Broek, dr. F.van der Hilst, dr. R. Harmsen	
Open to other students	Yes, but only for Innovation Sciences students	
Entry requirements		
Entry requirements	Students must be registered in one of the following degree programmes: Energy Science, Innovation Sciences	
Assumed previous knowledge	Basic knowledge on energy	
Course content		
Objectives	The course aims to provide insights into the central role that energy plays in the sustainability debate. The course addresses key challenges of energy use as well as the policies that have been developed to address them. Upon completion of the course, the participants will be able to: • Describe the main trends in energy supply and energy demand • Understand the key mechanism underlying climate change • Understand the main policy responses to climate change • Understand the influence of anthropogenic and natural emissions in the climate system as well as identify the main uncertainties and knowledge gaps • Understand the impacts of energy use in the environment (e.g., air emissions, water acidification, toxicity) • Specify the requirements of energy systems from a sustainability point of view (e.g, environment, reliability, security, accessibility) at different scales (local, national, regional and global) • Understand the role of policies aimed at improving energy efficiency, stimulating the application of renewable energy, and reducing greenhouse gas emissions • Explain the main mechanisms underlying policy instruments and identify their main strengths and weaknesses	
Content	Energy is a strategic commodity, which is fundamental to all (economic) activities. The costs, availability and the clean and efficient utilization of energy are increasingly strong focal points in the strategies and policies of governments worldwide. Therefore, it is essential for energy experts to understand key energy trends, the consequences of energy use and the effectiveness of policies to optimize energy systems. Energy is and will remain a major challenge both for developing and developed countries for the following reasons: • Lack of access to diverse and affordable energy services means that the basic needs of millions of people are not being met;	

	• Energy services are needed to create jobs, develop industries, enhance value added activities and support income-earnings activities; • The environmental effects of energy use can occur at many levels, from local to global and include consequences such as desertification, acidification, air pollution and climate change. The course will offer a strong combination of the latest energy developments, detailed insights into the main challenges of energy use and the key principles of policy formulation. The course uses a combination of lectures and tutorials to provide students with balanced and integrated knowledge that will allow them to develop critical understanding of the aspects involved on promoting sustainable production and use of energy. The course covers the following topics: • Trends in energy production and use • Environmental impacts of energy use • Physics of climate change • Basics of policy evaluation • Policy responses to climate change • Energy access and energy security • Trends, potentials, bottlenecks and policies for renewable energy (biomass, wind), geothermal and energy efficiency • Sustainability paradigms
Entry requirement for	This course is an entry requirement for: • Master's thesis (GEO4-2510) • Natural Science Research Project (GEO4-2518) • Internship Energy Science (GEO4-2520)
Instructional modes	
Instructional modes	Lectures (Required) Tutorials (Required)
General remarks	Lectures: This course is based on lectures (twice a week) and tutorials.
Class session preparation	In order to successfully participate in class, assigned literature should be read before lectures and tutorials.
Contribution to group work	A presentation and a working paper are conducted in small groups (4 and 2 respectively). Each member of the group is expected to equally contribute to the assignments.
Assessment	
Explanation	Exam, group assignment (presentation + short report) and a working paper
Study materials	
Literature	Required: Reader: Course reader (available in Blackboard), articles and report (available in blackboard) lecture notes

ENSM-Energy Systems Modelling		
Code: GEO4-2515	**Credits: 7,5 EC**	**Level: M**
Programme	ES	
Status	Obligatory	
Period/Timeslot	3 A	
Language	English	
Coordinator	dr. ir. M.A. van den Broek	
Instructor(s)	dr. ir. M.A. van den Broek	
Open to other students	Yes	
Entry requirements		
Entry requirements	None	
Assumed previous knowledge	Energy Analysis (GEO3-2223) and Advanced Energy Analysis (GEO4-2508)	
Course content		
Objectives	After completion of this course students are able to: • explain the context in which energy systems models are used and for what purposes; • explain the technological and economic principles and modelling methods underlying the state of the art energy system models; • build simple energy systems models (linear programming models and computable general equilibrium models in excel, power system simulation model in Plexos, and system dynamics models in VENSIM). • evaluate the results of an energy systems model based on its modelling method and inputs; • evaluate scientific articles and reports based on energy system model results considering the strengths and weaknesses of the models; • understand the uncertainties related to energy system modelling processes; • apply tools to assess uncertainties in energy systems modelling processes.	
Content	This course covers: • The uses of energy system models by, among others, energy and climate policy makers, energy companies, and grid operators. • Distinction between different types of models ranging from macro-economic to technology oriented models, simulation to optimisation models, static to dynamic models. • The way processes in the energy-economic system are modelled in different types of models. These concern short and long term dynamic processes related to energy supply, energy demand, energy conversion, population growth, economic growth, economic structural change, resource depletion, substitution, innovation, intermittent renewable electricity generation, energy storage, and technological learning. • Uncertainty assessment in energy systems modelling processes. • Techniques of Computable general equilibrium models, System Dynamic models, Linear programming models, power system simulation models,	

	Monte Carlo analysis, sensitivity analysis, and scenario analysis.
Entry requirement for	This course is an entry requirement for: • Master's thesis (GEO4-2510) • Natural Science Research Project (GEO4-2518) • Internship Energy Science (GEO4-2520)
Instructional modes	
Instructional modes	Lecture (Required) Assignments (Required)
General remarks	Lecture: Presence strongly advised. Assignments: The focus of instruction mode will be on computer assignments in which students will work with and create simple energy system models and tools. The basic principles underlying the models and their uses, strengths and weaknesses will be provided in accompanying lectures.
Class session preparation	Lecture: It is expected that students read the relevant and required literature prior to the lectures and assignments.
Assessment	
Explanation	Energy systems modelling assignments (peer review and grading by staff and students) and a final exam.
Study materials	
Literature	Required: Miscellaneous: Selection of articles and sections from reports and books, and lecture slides.

ENSM-Writing a Scientific Article		
Code: GEO4-2516	**Credits: 7,5 EC**	**Level: M**
Programme	ES	
Status	Elective	
Period/Timeslot	N/A	
Language	English	
Coordinator	dr. ir. C.A. Ramirez	
Instructor(s)	Various lecturers of the department IEES	
Open to other students	No	
Entry requirements		
Entry requirements	Students must be registered for the following degree programme: Energy Science. Minimum mark of 8.0 for Master's thesis or Natural Science Research Project, AND invitation from Master's thesis's or Natural Science Research Project's supervisor.	
Course content		
Objectives	After completion of this course the student is able to: • understand the process of writing and publishing a scientific article; • select an international journal and adapt his/her writing to the requirements set by the journal; • apply general conventions about writing in scientific journals into his/her article; • analyze and interpret scientific literature in the area, and • translate the research conducted in the master thesis or natural science research project into a publishable article.	
Content	During this course you will work towards a draft article, ready to be submitted to an international peer reviewed journal. You will write the article about the results of your Master's thesis research or your natural science research project. During the course you will be guided through a series of steps, demonstrating the process of publishing scientific work. Academic skills: *writing an article*	
Entry requirement for	This course is an entry requirement for: N/A	
Instructional modes		
Instructional modes	Individual (Required)	
General remarks	Your thesis supervisor will coach you through the steps. Your thesis supervisor will also be a co-author.	
Assessment		
Explanation	• Your final draft article (70%) • Evaluation from the supervisor on the process of preparation and writing (30%)	

Study materials	
Literature	Required: Study guide: Course Instruction Manual Literature: Malmfors, B. , Gransworthy, P. & Grossman, M., Writing and Presenting Scientific Papers. Nottingham: Nottingham University Press, 2004 (2nd edition)

ENSM-Tailor-made course Energy Science		
Code: GEO4-2517	**Credits: 7,5 EC**	**Level: M**
Programme	ES	
Status	Elective	
Period/Timeslot	N/A	
Language	English	
Coordinator	dr.ir. C.A. Ramirez	
Instructor(s)	Various lecturers	
Open to other students	No	
Entry requirements		
Entry requirements	Students must be registered for the following degree programme: Energy Science. Number of credits achieved: 45 EC of the master program Energy Science.	
Course content		
Objectives	Build on competences of the student in relation to the degree requirements of the master programme.	
Content	In the Master's programme, there is room for electives, depending on the programme and the number of EC for the Master's thesis. The Master electives may be extra courses or any other type of activity that aids to the competences of the student in relation to the degree requirements of the Master's programme. Examples are research projects, workshops, summer schools, etc. These Master activities may be incorporated in a Tailor-made course. The student takes the initiative to formulate a proposal for a Tailor-made course (GEO4-2517) and must find a staff member willing to provide guidance and grading during the course. The proposal must be approved by the Board of Examiners and should contain at least the following elements: 1. start with "*Proposal for a Tailor-made course within the master programme Energy Science*"; 2. Name and student number; 3. Date; 4. Supervisor (staff member); 5. Title for your course; 6. Intended learning outcomes; 7. Relation of learning outcomes to Master's programme degree requirements; 8. Short description of activities; 9. End products; 10. Mode of assessment; 11. Time planning. After the proposal has been written, it must be signed by the staff member who is supervising and grading the course, and then be sent to the Board of Examiners. Please note that these procedures take time, so *start with organising your Tailor-made course well ahead of the start date.* The course will not start until the Board of Examiners has approved your proposal. The Board of Examiners may take a maximum of 6 weeks to assess your proposal. If you have any questions regarding the possible content of your Tailor-made course please contact your Master programme leader.	
Entry requirement for	This course is the entry requirement for: N/A	

Instructional modes	
Instructional modes	Individual (Required)
General remarks	Dependent on the content of the proposed Tailor-made course.
Assessment	
Explanation	This should be explicitly defined in the proposal.
Study materials	
Literature	Dependent on the content of the proposed Tailor-made course.

ENSM-Natural Science Research Project		
Code: GEO4-2518	**Credits: 30 EC**	**Level: M**
Programme	ES	
Status	Obligatory for track NS; only for students that started in 2013-14 or later	
Period/Timeslot	N/A	
Language	English	
Coordinator	dr. W.G.J.H.M. van Sark	
Instructor(s)	Lecturers of Departement IEES	
Open to other students	No	
Remarks	**This course is only for students that started the MSc in Energy Science, track NS on or after 01-09-2013. Students in the NS track that started before 01-09-2013 should register for GEO4-2511.**	
Entry requirements		
Entry requirements	Students must be registered for the following degree programme: Energy Science. The following course must be completed: - ENSM-Advanced Energy Analysis (GEO4-2508) and at least three of the following courses must be completed: - ENSM-Energy Systems Modelling (GEO4-2515) - ENSM-Energy in the Context of Sustainability. (GEO4-2514) - ENSM-Energy Conversion Technologies II (GEO4-2503) - ENSM-Energy Conversion Technologies I (GEO4-2502)	
Assumed previous knowledge	At least two natural science electives	
Course content		
Objectives	The main aim of the Natural Science Research course is to train students in independently conducting research in the energy science related natural science field.	
Content	The Natural Science Research course is a research project in which the student will learn to conduct research independently in the field of energy-related natural science. The research should be relevant from both a scientific point of view (it should expand the body of scientific knowledge) and a societal point of view (it should produce knowledge that can contribute to addressing energy-related problems in society). Note, the focus is on natural science. The student delivers two outputs: • Thesis. A thesis is written in English. The student is encouraged to write the thesis in the form of a scientific article that is suitable for publication in a refereed journal. • Oral presentation. The purpose is to elaborate on the project for a scientific audience. This can take the form of a presentation for the colleagues in the department or attendees at a scientific conference. Academic skills: *writing a thesis, oral presentation*	
Entry requirement for	This course is an entry requirement for: N/A	

Instructional modes	
Instructional modes	Individual (Required)
Assessment	
Explanation	Report (70%), process (20%) and presentation (10%)
Study materials	
Literature	To be decided on an individual basis.

ENSM-Consultancy Project Energy Science		
Code: GEO4-2519	**Credits: 15 EC**	**Level: M**
Programme	ES	
Status	Obligatory for track SA	
Period/Timeslot	4 A+B+C+D	
Language	English	
Coordinator	dr. F. van der Hilst	
Instructor(s)	dr. F. van der Hilst	
Open to other students	No	
Remarks	**This course is only for students in the Systems Analysis track of the Master Energy Science**.	
Entry requirements		
Entry requirements	Students must be registered for the following degree programme: Energy Science.	
Assumed previous knowledge	Advanced Energy Analysis (GEO4-2508) and Energy Systems Modelling (GEO4-2515)	
Resources for self study	e.g. Blok, K. (2006). Introduction to Energy Analysis. Amsterdam, Techne Press.	
Course content		
Objectives	The consultancy project is a training for doing research on sustainable energy and materials. The main objective of this course is acquiring skills to be able to carry out research work independently and apply them to a project assignment within the consultancy project. After the completion of the course, the student: • is able to carry out research independently • has learned to rapidly familiarize himself with a new research topic • is able to present academic research both orally and in a written report • possesses project management skills • has learned to work in a team	
Content	The consultancy project is a training for doing research on energy and material systems. You will acquire the proper skills to carry out a research project independently. This course is the link between the cursory education of the first year of the Energy Science master and the research project in the second year of the master. The course consists of two parts: a general methodological part and a consultancy assignment. In the first part, students gain knowledge on project management and research skills in general, including: • project management (general theory and overview of approaches) • working in a team (including team roles, meeting skills, conflict management and a game to test your abilities to work together as a team) • defining a research question and develop a research plan (incl. time schedule)	

	• choosing the right research methods and the level of detail needed • finding (and evaluating) data in scientific and grey literature • generating own research data e.g. setting up interviews, • presenting your work in public • writing a scientific report. For the second part, students will work on a real consultancy assignment. In the consultancy project the students will work in groups of approximately 5-6 students to solve a concrete problem on energy and/or material use. The projects are carried out for real clients. Examples of past assignments are making an energy plan for drugstore chain Kruidvat, or investigating the use of renewable energy and energy efficiency improvement options throughout the entire coffee supply chain of Sara Lee. In a typical assignment, groups will carry out a technical and financial assessment, may investigate the possibilities for renewable energy production, energy saving potentials and other means to reduce GHG emissions, use materials more efficiently etc. In other words, the students will apply skills mainly acquired during the AEA course, but also other courses of the first year of the ES master. It is crucial that students subscribe in time for the course (i.e. in February) so that sufficient projects can be prepared. The annual projects will be made available two weeks before the start of the course, so that students can indicate their preference.
Entry requirement for	This course is an entry requirement for: N/A
Instructional modes	
Instructional modes	Supervision meetings (Required) Excursion Lectures (Required) Lecture interview techniques Presentations (Required) Feedback sessions (Required)
General remarks	As the Consultancy project is a 15 EC course, it is expected that students will work full time on this course. Because students will work in groups and together with the clients, students are expected to be available during office hours. The lectures are scheduled in the beginning of the course, but it is also expected that the groups will start with the consultancy assignment right away.
Assessment	
Explanation	The final mark is calculated from the marks in subtasks in the following way: • Research proposal - 10% • Review Research Proposal - 5% • Pecha Kucha presentation - 5% • Final report - 30% • Final presentation - 10% • Individual contribution - 30% • Group process - 10%
Study materials	
Literature	Required: Reader: Course reader (digitally available on Blackboard) Yet to be specified: Compulsory and recommended reading will be available via Blackboard. One of the key tasks of the students is to find relevant literature and data for their project. Students should check Blackboard regularly for updates on course information.

	Instruction form: A number of guidelines can be found on Blackboard, on e.g. how to write the research proposal and the report. Also, the assessment forms are uploaded on Blackboard.

ENSM-Internship Energy Science		
Code: GEO4-2520	**Credits: 22.5 EC**	**Level: M**
Programme	ES	
Status	Elective for track SA; only for students in track SA that started in 2013-14 or later.	
Period/Timeslot	N/A	
Language	English	
Coordinator	dr.ir. C.A. Ramirez	
Instructor(s)	dr.ir. C.A. Ramirez	
Open to other students	No	
Remarks	**Only open to students who started on or after 01-09-2013, track Systems Analysis. Students who started earlier should register for GEO4-2509**.	
Entry requirements		
Entry requirements	Students must be registered for the following degree programme: Energy Science. The following course must be successfully completed: - ENSM-Advanced Energy Analysis (GEO4-2508) and at least 3 out of the following courses must be successfully completed: - ENSM-Energy in the Context of Sustainability (GEO4-2514) - ENSM-Energy Systems Modelling (GEO4-2515) - ENSM-Energy Conversion Technologies I (GEO4-2502) - ENSM-Energy Conversion Technologies II (GEO4-2503)	
Assumed previous knowledge	Consultancy project (GEO4-2519)	
Course content		
Objectives	The main aim of the internship is to train students working in a professional organization that is active in the field of energy and materials.	
Content	The internship should be carried out in a professional organization outside the university where you can expect career opportunities. Examples are private companies, consultancies, governmental institutions, NGOs etc. During the internship you should carry out one single project that will result in a report supported by the hosting organization and the university. The internship project should contribute to solving a problem in the field of energy, climate and materials and it must be relevant for policy or management. The student delivers three outputs: an internship proposal (within four weeks of having started the internship); an internship report and an oral presentation.	
Entry requirement for	This course is an entry requirement for: N/A	
Instructional modes		
Instructional modes	Internship (Required)	
General remarks	The internship will require a supervisor from the host institution and a supervisor from Utrecht university. The supervisor from the university is responsible for the grading.	
Assessment		
Explanation	Process (70%), quality of the report (20%) and presentation (10%)	

Study materials	
Literature	Depends on the internship project.

ENSM-Bio-based Economy		
Code: GEO4-2521	**Credits: 7.5 EC**	**Level: M**
Programme	ES	
Status	Elective for ES, SUSD, SBI, IS and Chemistry	
Period/Timeslot	3 B	
Language	English	
Coordinator	Prof. Dr. H. M. Junginger	
Instructor(s)	Dr. V. Daioglou Dr. F. van der Hilst Dr. R. Hoefnagels Prof. Dr. H. M. Junginger Dr. M. Londo Dr. A. Ramirez Dr. Li Shen Dr. B. Wicke and others	
Open to other students	Yes	
Remarks	**This course is especially recommended for students that want to write their MSc thesis on BBE-related topics.**	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Energy Science, Innovation Sciences, Sustainable Business and Innovation, Sustainable Development, Chemistry.	
Assumed previous knowledge	It is strongly recommended (but not required) that students should have followed at least one of the following courses • Advanced energy analysis (GEO-2508) • Life Cycle Analysis (GEO3-2124; BSc course) • Toolbox 1 (GEO4-2602) • Science and technology for Sustainable development (SK-BCHDO; BSc course)	
Course content		
Objectives	The objective of this course is to provide students with the knowledge and insights needed to understand the potential future role of a biobased economy (BBE) in a sustainable world, including its possibilities and limitations. After completion of the course, the students should be able to: • understand the technical and economic possibilities and limitations of biomass to substitute fossil fuels for the production of energy, chemicals and materials, including the complexity of determining the ideal use/cascade of biomass for materials and energy • explain the main sustainability challenges that are linked to the production and use of biomass, including the possible contribution that biomass use for energy, chemicals and materials can make to mitigate climate change • discuss the main uncertainties concerning the opportunities and risks of BBE, and the related issues to concerning economic and/or environmental policy strategies	
Content	Biomass is an important feedstock to produce food, fodder, materials and energy. Given the environmental concerns of fossil fuel use for the production of materials and as energy carrier, the use of biomass is expected to strongly increase in the coming decades as a feedstock for the bio-based economy. However, developing the bio-based economy is not straightforward: (1) there are limited amounts of	

	feedstock and potential (environmental and other) impacts of feedstock production and biomass use; (2) there are a large-number of possible applications and end-uses; and (3) the (currently often unfavorable) economics compared to fossil fuels make deployment difficult. The course examines the potential deployment of biomass (for a biobased economy) from a system perspective, from feedstock production until final use. The course takes an interdisciplinary approach thereby looking at the physical, technical, economic, environmental and policy aspects involved on the deployment / transition towards a biobased economy. Topics that will be treated during the course include: • Definition and overview of the historic and current biobased economy in the Netherlands, Europe and the world, including traditional and new uses of biomass for energy and materials. • EU and global biomass potentials (current – 2100) and key factors determining this potential (including overall land-use patterns and agricultural productivity) • The role of biomass logistic chains (including pretreatment & storage strategies) and international trade • Current and future biochemical and thermochemical conversion routes from various biomass feedstocks to energy carriers and materials and the related types of biorefineries (including integrated bio-refinery concepts) • Overview of possible end uses of biomass for energy (electricity; heat; road, aviation and marine transport fuels) and materials (including biobased plastics, bulk and fine chemicals, advanced fibers and building materials etc.) • GHG performance of biomass use for energy and materials, including life-cycle chain emissions (including recycling), land-use change effects and temporal effects • Sense and non-sense of cascading and links with the circular economy concept • Other potential environmental benefits and impacts of biomass use for energy and materials • Overview of past and current policy strategies to promote and govern sustainable biomass production and use • Macro-economic perspectives and socio-economic aspects of a biobased economy *Academic skills: Writing a paper*
Entry requirement for	This course is an entry requirement for: N/A
Instructional modes	
Instructional modes	Lecture (Required) Exercise class (voluntary) Excursion (Voluntary)
Assessment	
Explanation	Individual final paper, topics will be announced at the beginning of the course Individual written exam.
Study materials	
Literature	Required: Course reader (available on blackboard), lecture notes, scientific articles (available on blackboard)

SBI-Toolbox 1: Environmental Assessment and Management Approaches		
Code: GEO4-2602	**Credits: 7,5 EC**	**Level: M**
Programme	SBI/SD/ES/WSM/IS/Chemistry	
Status	Obligatory for SBI; Elective for other programmes	
Period/Timeslot	2 D	
Language	English	
Coordinator	dr. H.M. Junginger	
Instructor(s)	dr. H.M. Junginger	
Open to other students	Yes	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Energy Science, Water Science and Management, Innovation Sciences, Sustainable Business and Innovation, Sustainable Development, Chemistry	
Assumed previous knowledge	Basic background of natural science, e.g. knowing the difference between a kW and a kWh.	
Previous knowledge can be gained by	Following the Bachelor course on Life Cycle Assessment (GEO3-2124)	
Resources for self study	Scientific literature provided on blackboard (mandatory). Recommended (but not obligatory): Henrikke Bauman. Anne-Marie Tillman, The Hitch Hikers guide to LCA. Gazelle Book Services, 2004. ISBN 9144023642, 9789144023649	
Course content		
Objectives	The objectives of this course are to introduce students to a variety of tools and approaches to assess, manage and improve the environmental impact of products and production processes. After completion of the course, the students: • have insight in the most important (research) methods and tools to assess and manage the environmental impact of products, production processes and services; • know strong and weak points of each tool and understand the level of uncertainty in using them; • can critically interpret studies that are carried out using these tools and are able to carry out basic calculations themselves.	
Content	The course will focus on the sustainability of products and production processes of firms. About two thirds of the course will focus on tools to assess the environmental (and to a limited extent social and economic) impact of products and production processes, and will be based (mainly) life cycle assessment (LCA), including carbon footprinting. In 3-4 lectures, a general introduction and explanation of concepts such functional unit, different ways of allocation and the difference between attributional & consequential LCA will be provided. Also one or two concrete case studies on how LCA's are carried out, interpreted and used by firms will be presented. Next to two assignments, also, two half-day LCA computer practical will be held introducing the students to SimaPro. Other approaches covered during lectures will include an introduction to environmental impact assessment (EIA) to	

	evaluate the impacts of location & time specific projects, and to environment risk assessment (ERA) to assess uncertainty and long-term risks of products and production processes. In the remaining third of the course, the students will gain knowledge on concepts how products and production processes can be improved and last but not least how the economic implications of these changes can be assessed. This will include an introduction to concepts such as circular economy (CE). cradle-to-cradle (C2C), eco-design, cleaner production, and to economic concepts such as net present value (NPV), internal rate of return (IRR) and Life Cycle Costing (LCC). The course mainly aims to provide an overview of the state of the art of current tools in use. A secondary aim is to highlight on-going trends in academia and the further development and expansion of existing concepts, such as the development of social and socio-economic LCA. Academic skills: • Comprehending (and to a limited extent applying) the scientific concepts and tools taught in the course; • Understanding and critically reviewing scientific articles, including a review of an existing LCA study and writing a concise review paper; • Making and presenting a scientific poster.
Entry requirement for	This course is an entry requirement for: Consultancy Project SBI (GEO4-2605) and Master's Thesis Internship (GEO4-2606).
Instructional modes	
Instructional modes	Lectures by UU staff members and guest speakers Poster presentation (Required) Tutorials & practicals 1-day Excursion
General remarks	Lectures will be both by UU staff and guest lecturers from companies (previously we had e.g. Philips, Shell, Royal Haskoning, CO_2 performance ladder, Desso and Interface).
Class session preparation	You should prepare for lectures by reading the literature provided on Blackboard in advance
Contribution to group work	You will perform a critical review of an existing LCA study (see assessment) in groups of 3-4 persons. You are expected to meet with your group on your own to discuss the assignment and prepare the paper. All group members are expected to contribute equally to the assignment.
Assessment	
Explanation	The assessment will be carried out by means of a written, closed-book exam (50% of the final grade). The other 50% will be covered by a group assignment to analyse and critically review an existing LCA study. The deliverables that will be assessed are a paper with your critical review (40%) and a poster presentation where you present the LCA study and your review to your peers (10%).
Study materials	
Literature	Required: Reader: will be available digitally on blackboard. No hardcopy will be provided. Items: List of scientific articles on Blackboard

SBI-Toolbox 2: Socio-organizational Methods for Corporate Sustainability		
Code: GEO4-2603	**Credits: 7,5 EC**	**Level: M**
Programme	SBI/ES/IS/SD/WSM	
Status	Obligatory for SBI; Elective for other programmes	
Period/Timeslot	3 C	
Language	English	
Coordinator	dr. W.J.V. Vermeulen	
Instructor(s)	dr. W.J.V. Vermeulen, ir. S. Witjes	
Open to other students	Yes	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Energy Science, Water Science and Management, Innovation Sciences, Sustainable Business and Innovation, Sustainable Development.	
Assumed previous knowledge	Business and Sustainability Challenges (GEO4-2601) and Technology Related Venturing (GEO4-2268)	
Course content		
Objectives	The objectives of this course are: • Make students aware of the theoretical background and methods applied in practice of the tools which companies apply in order to be able to manage sustainability internally and externally. • Make students acquainted with theoretical concepts and models relevant for these tools. • Give the students the possibility in group work and in individual work to analyse and reflect upon case studies. After completion of the course, the student: • Has advanced knowledge and understanding of the organisational and management processes related to the contribution to corporate sustainability; • Has advanced knowledge and understanding of various tools and methodologies related to corporate sustainability and is able to compare and relate them to each other and assess them form a comprehensive synthesis perspective; • Can recognise organisational structures and its elements assuring the compliance with corporate sustainability;	
Content	In this course 4 elements will be addressed: • *Stakeholder relations*: Who are they, why are they relevant, how can they influence the sustainability of a company and how can companies engage with them? • *Management systems and standards*: How do companies assure that the whole organization is working towards the set goal for sustainability? • *Selling your corporate and product sustainability*: Who are the customers and what are companies doing to sell the fact that they are sustainable of that they have sustainable products?	

	• *Value chain management*: What is the value chain in the sustainability of a company and how can companies collaborate with value chain partners, ensuring sustainable production practices in the entire value chain? For every element there is a mixture of theoretical knowledge, contact with practice and the possibility for the students to explore themselves these elements by means of assignments. Academic skills: *after completion of the course, the student:* • *is able to connect with companies and communicate with them about integrating Corporate Sustainability;* • *is able to understand organisations, their internal and external stakeholders, and how they influence and contribute to sustainability;* • *critically reflect on and analyse organisations and their context, in order to be able to understand the playing field of corporate sustain*ability.
Entry requirement for	This course is an entry requirement for: Master's Thesis Internship (GEO4-2606)
Instructional modes	
Instructional modes	Lectures (Required); Seminars (Required)
General remarks	Lectures, group papers, presentation and debate.
Class session preparation	Readings for lectures; readings for group assignment
Contribution to group work	Prepare presentations and paper in small groups (3-5 students)
Assessment	
Explanation	• Exam (40%) • Group work (18%) • Presentation of assignments (12%) • Final group paper (30%)
Study materials	
Literature	Reader with online resources and list of scientific articles

SBI-Organizational Change Management for Sustainability		
Code: GEO4-2604	**Credits: 7,5 EC**	**Level: M**
Programme	SBI/IS/SD/ES/WSM	
Status	Obligatory for SBI; Elective for IS, SD, ES and WSM	
Period/Timeslot	2 A	
Language	English	
Coordinator	dr. A. Kalfagianni	
Instructor(s)	dr. A. Kalfagianni, D. Reike, MSc	
Open to other students	Yes	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Energy Science, Water Science and Management, Innovation Sciences, Sustainable Business and Innovation, Sustainable Development	
Assumed previous knowledge	Business, Sustainability and Innovation (GEO3-2122) or equivalent	
Course content		
Objectives	The course provides the students the skills and knowledge to engage with organisational change management for sustainability. The course content is designed to address the nature of change, what drives it, what are the barriers to change, and how can these be overcome. This is aimed at providing students with skills in change management, which should improve their employability in organisations that are working towards sustainability. This course is designed to develop understanding, critical awareness, and skills for effective action and problem solving; particular emphasis will be placed on developing the follow competences: • To familiarise students with the key principles of organisational systems and their respective attitudes, and how they influence and contribute to sustainability • To familiarise students with change management for corporate and organisational sustainability • To develop the students' understanding on the complexities of change management in organisations (such as corporations and universities), and how it can contribute to more sustainable societies • To enable students to critically think and reflect on and analyse key literature and case studies • To enable students to implement recommendations to organisations to help them become more sustainability orientated, and improve employability After completion of the course, the student will be able to: • understand organisations, their elements, and their attitudes, and how they influence and contribute to sustainability; • understand the different types of change and how they can be managed in the corporate sustainability context; • recognise drivers, barriers to change, and strategies to overcome the barriers in a sustainability context within the organisation; • critically reflect on and analyse organisations, in order to be able to	

	implement change management for sustainability.
Content	Sustainability has appeared as an alternative to development models prioritising economic activities at the expense of environmental and social issues. Sustainability aims to produce a dynamic balance among economic, environmental and social aspects, and the time dimension. A variety of corporate efforts, (such as Life Cycle Assessment, Eco-efficiency, and Corporate Social Responsibility), are being used to incorporate Sustainability principles into companies and organisations' activities. Nonetheless, in many cases these efforts have been limited by their focus on a particular Sustainability issue, 'hard' technocentric solutions, or not being effectively integrated into organisational change processes. This course is aimed at operationalizing the tools and techniques by engaging with internal stakeholders, i.e. employees. It is also aimed at providing the students a more in depth understanding of a company's culture The course structure is: • Introduction • Organisations and their systems • Attitudes and behaviour • Change management in the organisational sustainability context • Principles and concepts of change management • Types of change • Processes of change • Drivers to change • Change incorporation • Resistance to change • Barriers to change • Strategies to overcome change • Steering mechanisms • Institutionalisation For every element there is a mixture of theoretical knowledge, contact with practice and the possibility for the students to explore themselves these elements by means of assignments.
Entry requirement for	This course is an entry requirement for: Master's Thesis Internship (GEO4-2606) and Consultancy Project SBI (GEO4-2605)
Instructional modes	
Instructional modes	Lectures (Required); Seminars (Required)
General remarks	Lectures, Guest Lectures, Interactive and participatory Workshops, and Student meetings
Assessment	
Explanation	See course manual
Study materials	
Literature	List of scientific articles

Energy and Environmental Economics		
Code: ECMENE	**Credits: 7,5 EC**	**Level: M**
Programme	SD/ES	
Status	Elective	
Period/Timeslot	3 B	
Language	English	
Coordinator	dr. M.J.W.L. Sanders (m.w.j.l.sanders@uu.nl)	
Instructor(s)	dr. M.J.W.L. Sanders	
Open to other students	Yes	
Remarks	**Registration for this course in Osiris runs from 30 October – 27 November 2016.**	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Economics of Public Policy and Management, Energy Science, International Economics and Business, Sustainable Development	
Recommended pre-requisites	None	
Course content		
Objectives	• Combine theory and empirical skills to the issues related to energy production and use; • Critically evaluate work of others on these dimensions; • Formulate and complete a scientifically researched policy proposal on energy transition.	
Content	Research on global climate change, geopolitical considerations and environmental degradation has established the necessity and desirability of a transition towards a more environmentally and strategically sustainable energy system. At the other end, scientists and engineers have developed many options and technologies that would make this transition feasible. Still, the transition is taking place at a painstakingly slow pace, if at all. As energy is such a fundamental input in modern economies, the challenge of bringing this transition about is huge. In this course we study what economics has to offer in understanding this challenge. In the first part of the course we turn to environmental policy making with a focus on the European context from week 1. We discuss the basics of resource and environmental economics, review investment behaviour under uncertainty and input-output and productivity analysis and the economics of innovation and technical change. In designing effective policies for energy transition we will touch upon a wide variety of sub-disciplines, fields and topics in economic research. Given its multidisciplinary and applied nature this course is open to most students in the academic MSc. programmes at U.S.E.. For all students it offers new topics but may also have some repetition. The course is also open to master students from other disciplines. You should therefore be prepared to study quite advanced material from less familiar fields in some and explaining concepts that are by now basic to you to your fellow students from other fields and disciplines in other weeks. By integrating these disciplines we aim to get all students to a level of understanding that is required for addressing the issue at hand and we explicitly aim to avoid ending up with the lowest common denominator.	
Entry requirement for	N/A	

Instructional modes	
Instructional modes	Lectures, guest lectures, referrals, discussion meetings and assignment
Assessment	
Explanation	• Written exam on the basic economics (20% individual); • Participation in-group discussions (20%) through peer evaluation. • Written assignment (60%). This is an individually graded group assignment: the students write an individual policy proposal that is integrated into a joint policy paper. They are graded individually on the policy proposal and jointly on the introductory parts (identification of major challenges) and joint conclusion, the presentation at the conference and the discussant role they take on other papers.
Study materials	
Literature	Obligatory: Roger Perman, Yue Ma, Micheal Common, David Maddison & James Mcgilvray (2011). Natural Resources and Environmental Economics, Addison-Wesley. ISBN13: 9780321417534, Softcover Recommended: Course manual; electronic reader

SBI-Sustainable Entrepreneurship		
Code: ECMSE	**Credits: 7,5 EC**	**Level: M**
Programme	SBI	
Status	Obligatory for SBI; elective for IS, SD, ES, WSM and SBM Required for the university wide Annotation Sustainable Entrepreneurship & Innovation.	
Period/Timeslot	3 D	
Language	English	
Coordinator	dr. N.S. Bosma (n.s.bosma@uu.nl)	
Instructor(s)	dr. N.S. Bosma	
Open to other students	Yes	
Remarks	**Registration for this course in Osiris runs from 30 October – 27 November 2016.**	
Entry requirements		
Entry requirements	Students must be registered for one of the following degree programmes: Energy Science, Water Science and Management, Innovation Sciences, Sustainable Business and Innovation, Sustainable Development, Science and Business Management.	
Recommended pre-requisites	International Business Ventures (ECMIBV)	
Course content		
Objectives	This course is designed to provide academic knowledge related to idea development, value proposition, market introduction and management of new sustainable business and to put these into practice. The major learning objectives include: • To provide understanding of (sustainable) entrepreneurship (what entrepreneurship is, cognitive foundations of entrepreneurship, and entrepreneurial opportunities, distinctive characteristics of entrepreneurs); • To analyse and evaluate the economic sources of social and environmental problems and to identify opportunities to alleviate or eliminate these problems and the underlying conditions; • To apply the accumulated knowledge by either developing a business model from scratch or by introducing an initially developed plan to the market by means of bootstrapping methods; This necessitates that students understand the concepts of sustainability and sustainable entrepreneurship, and that students learn about the economic, environmental and social problems facing local and global communities and recognise the opportunities that arise from this. Finally, students should be able to evaluate the risks and rewards of undertaking sustainable entrepreneurship, which involves finding ways to measure the economic as well as social and environmental risks and rewards of a new venture.	
Content	Entrepreneurship focuses on identifying new opportunities for creating value for customers or users and commercially developing those opportunities to establish a profitable business. Sustainable entrepreneurship combines the traditional focus of entrepreneurship with an emphasis on opportunities to alleviate social or environmental conditions. Sustainable entrepreneurship is about entrepreneurs striving simultaneously for profit and for improving local and global environmental and social conditions.	

	This course is addressed to students interested in exploring the challenges of sustainable entrepreneurship. The course will provide academic insights into the entrepreneurial process and in particular: • The opportunities and challenges of developing a new venture, given characteristics of the market and the institutional context; • The challenges of aligning profits with social and environmental value; The overall objective of this course is to make the students aware of the opportunities offered by an entrepreneurial career, the skills needed for and academic knowledge about entrepreneurial processes, in the context of sustainability. The course emphasizes the business & management perspectives to entrepreneurship.
Entry requirement for	This course is an entry requirement for: • Consultancy Project SBI (GEO4-2605) • Master's Thesis Internship (GEO4-2606)
Instructional modes	
Instructional modes	This course is an interactive and participatory course that teaches students the key concepts from theory to practice. It adopts a mix of lectures, tutorial sessions, workshops and activities related to the business model assignment. Students are expected to attend and participate in all lectures and take part in all tutorial sessions. The students will be allocated into groups (4 or 5 students) for the business model assignment. For each group the aim is to establish a mix of enrolled students from Utrecht University School of Economics and from Geosciences , in order to facilitate multidisciplinary work.
Assessment	
Explanation	The elements that constitute the final grade are the following: *Business Model Assignment (group work):* Groups will either develop a business model from scratch, or introduce developed ideas to the market. This will be achieved in several steps throughout the course period. The evaluation will be based on the quality of the final work, the presentation and the process towards the final document(s). *Business Case Assignment (group work):* Students will be presented with a case study and are required to answer questions that relate to the case. The questions focus on marketing and finance applied to sustainable entrepreneurship. The evaluation will be based on a concise report in which the answers are motivated. *Written Exam (individual work):* There will be a midterm exam that consists of open-ended questions. The questions are based on the key course concepts that are taught and discussed during the course. **Assessment method** • Written midterm exam with open-ended questions (30%); Individual • Evaluation of Business Case Assignment (20%); Group grade • Evaluation of business model assignment (50%). Group grade, with a group component (25%) and an individual component (25%).
Study materials	
Literature	• Sustainable Venturing: Entrepreneurial Opportunity in the Transition to a Sustainable Economy. Dean. ISBN-13.: 978-0136044895. Pearson: Boston • Syllabus with academic articles • Course manual

Appendices

Appendix I Rules for choosing elective courses

1. Students in the Master's programme choose elective courses from another or their own Master's programme. Courses that are obligatory in the examprogramme cannot be used as elective courses.

2. The student must subject in advance his elective courses to the approval of the Board of Examiners. The programme leader will advise the Board in this matter.

3. The Board tests the proposed elective course on the following criteria:
   a. They must be thematically linked to the Master's programme;
   b. The programme coordinator supports the proposition;
   c. It concerns a course at a master level (M);
   d. The course is not taught in the same period and timeslot as another course the student has selected.

4. Within these bounds students are **free to propose any course** (even in Dutch) from any other programme in the Faculty of Geosciences, the UU or another recognized University in the Netherlands (see www.vsnu.nl > universiteiten) or abroad. Useful sources to find electives are the Osiris webpage (www.uu.nl/osirisstudent).

5. If the student wishes to choose an elective course, he must do so by a written request (form) to the Board of Examiners and he must attach written information on the contents, the level, and the study load of the course, preferably by means of a copy of the course's description from the course catalogue. The 'Application Form Elective courses IMEW' can be found in the Blackboard community Energy Science or it can be downloaded at http://students.uu.nl/sites/default/files/geo-iees-application_form_optional_courses.pdf.

6. The student can either ask the programme leader to sign the application form or forwards an email containing the **programme leader's approval** to the Board of Examiners. The form (and email if applicable) and the course description can be sent to the Board's secretary, mrs. drs. Erika Dijksma (room 10.23, pigeon-hole at the 10th floor of the Unnik building).

7. Recommended elective courses as mentioned on the Blackboard community ES do not need to be approved by the programme coordinator but must still be approved *before starting* by the Board of Examiners.

8. Actual participation is only possible if the student satisfies the course's entrance conditions; in case of doubt he should contact the course coordinator first.

9. In the programme's course schedule, room has been reserved for taking electives. However, the student is free to deviate from this planning, e.g. because he wishes to take an interesting elective course in another period. If this causes delay in his study planning, the responsibility is for account of the student! Students are therefore advised to take their electives in the reserved periods and timeslots, or use a part of the time planned for their internship and/or Master's thesis.

Appendix II Education and Examination Regulations Graduate School Geosciences 2016-2017

The Education and Examination Regulations set out the degree programme-specific rights and obligations of students on the one hand and of Utrecht University on the other hand. The University's student charter contains the rights and obligations that apply to all students.

These Regulations were adopted by the Dean of the Graduate School of the Faculty of Geosciences on 26 April 2016 with the approval of the Faculty Council on 26 April 2016.

SECTION 1 – GENERAL PROVISIONS

Art. 1.1 – applicability of the Regulations

These Regulations apply to the teaching and examinations of the Master's degree programmes in Development Studies, Earth Sciences, Environmental Sciences, Geographical Sciences, Human Geography, Human Geography and Planning (research programme), Spatial Planning and Science and Innovation (hereinafter called the degree programmes) and to all students registered for these degree programmes and to all students who have applied for admission to these degree programmes for the academic year 2016-2017.
The degree programmes and individual Master's programmes are run by the Graduate School of Geosciences within the Faculty of Geosciences.

Art. 1.2 – definition of terms

In these Regulations, the terms below have the following meanings:
a. the Act: the Dutch Higher Education and Research Act 1992 (Wet op het Hoger onderwijs en wetenschappelijk onderzoek 1992, WHW).
b. student: a person who is registered at the University to take courses and/or sit the tests and final examination of the degree programme. In these Regulations, reference to a student is in the masculine form, in accordance with the General Regulations Guideline applicable to Dutch legislation.
c. credit: a value expressed in EC (according to the European Credit Transfer System), where the study load is expressed as one credit being equivalent to 28 hours of learning.
d. degree programmes: the Master's degree programmes referred to in Art. 1.1 of these Regulations, consisting of a coherent whole of units of study. A Master's degree programme may comprise several Master's programmes.
e. component: a unit of study (course) within the degree programme, as included in the prospectus and the University Course Catalogue.
f. course: the whole of education and testing of a component.
g. test: interim examination as referred to in Art. 7.10 of the Act.
h. examination: the final examination of the degree programme that is passed if all obligations of the entire Master's degree programme have been fulfilled.
i. special needs contract: the contract concluded by the Director of Education (or another officer on behalf of the degree programme) and the disabled student, which lays down the necessary and reasonable facilities to which the student is entitled.
j. International Diploma Supplement: the annex to the Master's degree certificate, which includes an explanation of the nature and contents of the degree programme (partly in an international context).
k. Board of Studies: the Board of the Graduate School of Geosciences.
l. Student Affairs Geosciences: student information desk and student progress administration unit of the Faculty.
m. course guide: document specifying for each course: the exit qualifications; the requirements (such as the attendance and effort requirements) that a student must meet to achieve the exit qualifications; the way in which the final grade is calculated; the timetable and the instructional formats; name and availability of the course coordinator.
n. academic vacation periods: periods without any teaching obligations for teaching staff and learning obligations for students, as laid down in the academic calendar for the degree programmes.
o. examiner: the assessor.

The other terms have the meanings ascribed to them in the Act.

SECTION 2 – ADMISSION

Art. 2.1 – admission requirements of the degree programmes

1. The holder of a Dutch or foreign higher education degree who possesses knowledge, understanding and skills at university bachelor's level and who demonstrates the specific knowledge, understanding and skills as specified in Annex 1, can be admitted to one of the Master's programmes.
2. Selection of students is based on a review of the following core competences of applicants:
   a) motivation and talent (partly based on GPA and study progress);
   b) level of relevant knowledge and competence in the methods and techniques of the field of study concerned;
   c) general level of academic and professional skills;
   d) level of proficiency in the language(s) of instruction used in the programme.

This information is used to assess whether a student is able to complete the Master's programme successfully within the nominal duration.

Art. 2.2 – English language (for Master's Degree Programmes taught in English)

1. Registration for the degree programmes is possible only after it has been demonstrated that the requirement of adequate command of the English language is fulfilled. Deficiencies in previous education in English must be made up before the start of the degree programme by sitting one of the following tests:
   - IELTS (International English Language Testing System), academic module. The minimum required IELTS score (overall band) is: 6.5 with at least 6.0 for the component 'writing'.
   - TOEFL (Test of English as a Foreign Language). The minimum required TOEFL score is 93 (internet-based test).
   - Cambridge EFL (English as a Foreign Language) Examinations, with one of the following certificates:
     - Cambridge Certificate in Advanced English; minimum score B.
     - Cambridge Certificate of Proficiency in English; minimum score C.
2. The holder of a university Bachelor's degree awarded in the Netherlands fulfils the requirement of adequate command of the English language.

Art. 2.3 – proficiency in Dutch for holders of foreign qualifications (for Master's Degree Programmes taught in Dutch)

Holders of a foreign diploma may only register:
1. once it has been demonstrated that the requirement of adequate command of the Dutch language has been fulfilled by passing the state examination in Dutch as a Second Language, Programme 2, or the certificate in Dutch as a Foreign Language, 'Educatief Professioneel' ('Educational Professional', previously 'Academic Language Skills Profile' (PAT)) or 'Educatief Startbekwaam' ('Educational Beginner's proficiency', previously 'Higher Education Language Skills Profile' (PTHO)), and
2. once it has been demonstrated that the requirement of adequate command of the English language has been fulfilled. Deficiencies in previous education in English must be made up before the start of the degree programme by sitting one of the following tests:
   - IELTS (International English Language Testing System), academic module. The minimum required IELTS score (overall band) is: 6.5 with at least 6.0 for the component 'writing'.
   - TOEFL (Test of English as a Foreign Language). The minimum required TOEFL score is 93 (internet-based test).
   - Cambridge EFL (English as a Foreign Language) Examinations, with one of the following certificates:
     - Cambridge Certificate in Advanced English; minimum score B.
     - Cambridge Certificate of Proficiency in English; minimum score C.

Art. 2.4 – deficiencies

1. The Board of Admissions of the Graduate School may require those applicants who do not meet the admission requirements referred to in Art. 2.1 to complete a package of courses to a maximum of 60 EC, to be taught by Utrecht University and tailored to the Master's programme concerned, in order to make up for prior educational deficiencies.
2. The Board of Admissions may establish in its decision that deficiencies must be made up within a certain period of time and prior to admission to the Master's degree programme.

Art. 2.5 – admissions procedures

1. Responsibility for admission to the degree programmes of the Graduate School and the various Master's programmes lies with the Board of Admissions of the Graduate School.
2. In order to determine eligibility for admission to the degree programme, the Board of Admissions will consider and evaluate the knowledge, understanding and skills of the applicant. The Board may request

experts within or outside the University to assess the applicant's knowledge, understanding and skills in particular areas, in addition to a review of written documents of qualifications gained.
3. In order to determine eligibility for admission to a programme within the Master's degree programme, the Board of Admissions will examine whether the applicant meets the admission requirements referred to in Art. 2.1(1) or will meet them in time. In its review, the Board will include the applicant's core competences referred to in Art. 2.1(2), as well as the applicant's knowledge of the programme's language of instruction. On this basis the Board of Admissions will assess whether the candidate is able to achieve the exit qualifications of the Master's degree programme with sufficient effort within the nominal duration of the programme.
4. Requests for admission to one of the degree programmes and to a specific Master's programme are submitted to the Board of Admissions before 1 April and 1 September. In special cases, the Board of Admissions may consider requests submitted after these closing dates.
5. The applicant will receive written notification whether or not he has been admitted to the degree programme and a specific Master's programme. The possibility to appeal to the Examinations Appeal Board will be indicated in this notification.

SECTION 3 – CONTENTS AND STRUCTURE OF THE DEGREE PROGRAMMES

Art. 3.1 – aim of the degree programmes

1. The degree programme aims to:
   - equip students with specialist knowledge, skills and understanding in the field of Geosciences, and help them achieve the exit qualifications referred to in paragraph 2;
   - prepare students for a career in one or more sub-fields of Geosciences;
   - prepare students for undertaking a programme to train as a researcher in the field of Geosciences.

2. The graduate:
   - has a deep knowledge and understanding of the subject matter of Geosciences;
   - has a thorough knowledge of a specialism in his degree programme and thorough knowledge at the interface of the degree programme and another field;
   - has the skills to identify, formulate, analyse and suggest possible solutions to problems independently in the field of Geosciences;
   - has the skills to conduct research in the field of Geosciences and to report on this research in a manner that meets the customary standards of the discipline;
   - possesses professional and academic skills, particularly in relation to the field of Geosciences;
   - is able to apply knowledge and understanding in such a way that demonstrates a professional approach to his work or profession;
   - is able to communicate conclusions, as well as the underlying knowledge, grounds and considerations, to an audience composed of specialists or non-specialists.

   The prospectuses for the Master's degree programmes set out the subject-specific exit qualifications for the different Master's programmes.

Art. 3.2 – mode of attendance

The degree programmes in Development Studies, Earth Sciences, Environmental Sciences, Human Geography and Planning (research programme) and Science and Innovation are offered full-time. The degree programmes in Spatial Planning, Geographical Sciences and Human Geography are offered full-time as well as part-time.

Art. 3.3 – language of instruction

The degree programmes in Development Studies, Earth Sciences, Environmental Sciences, Geographical Sciences, Human Geography and Planning (research programme), Spatial Planning and Science and Innovation are taught in English. The degree programme in Human Geography is taught in Dutch. The Master's programme Urban Geography within the degree programme Human Geography is taught in English.

Art. 3.4 – study load

The degree programmes in Earth Sciences, Environmental Sciences, Geographical Sciences, Human Geography and Planning (research programme) and Science and Innovation have a total study load of 120 credits. The degree programmes in Development Studies, Spatial Planning and Human Geography have a total study load of 60 credits.

Art. 3.5 – programmes; start dates

1. The Graduate School of Geosciences offers the following Master's degree programmes and Master's programmes:

Master's degree programmes	Master's Programmes
Earth Sciences	Earth, Life and Climate Earth Structure and Dynamics Earth Surface and Water Marine Sciences Water Science and Management
Environmental Sciences	Sustainable Development Water Science and Management
Geographical Sciences	Geographical Information and Management Applications
Human Geography and Planning	Urban and Economic Geography
Science and Innovation	Innovation Sciences Energy Science Sustainable Business and Innovation
Development Studies	International Development Studies
Spatial Planning	Spatial Planning
Human Geography	Economische Geografie Geo-communicatie Urban Geography

The Master's degree programmes prepare students for undertaking research in one or more sub-fields of Geosciences.

2. All Master's degree programmes have one start date a year: 1 September.

Art. 3.6 – components of the Master's programmes

1. The core components of the different Master's programmes and their study loads are described in Annex 1.
2. Upon approval by the Board of Examiners, the student will choose one or more components. The study loads for the elective components of the specific Master's programmes are set out in Annex 1.
3. In the prospectus, the contents and form of instruction of the components of the different Master's programmes are described in more detail, stating the prior knowledge desirable to pass the relevant component.

Art. 3.7 – components taken elsewhere

1. The condition for gaining the degree certificate of the Master's examination of the programme is that at least half of the Master's degree programme is passed in components provided by Utrecht University.
2. Components passed elsewhere during the degree programme can only be incorporated in the student's examinations programme with prior permission from the Board of Examiners.
3. Exemption can be granted for components passed at an institute of higher education prior to the start of the Master's degree programme only on the basis of Art. 5.13.
4. Contrary to Art. 3.7.3., components that have been passed in a Master's degree programme at Utrecht University prior to the start of the Master's degree programme may be counted towards the student's examinations programme with the classification awarded.

Art. 3.8 – actual teaching structure

The teaching structure of each course is shown in the University Course Catalogue and/or course guides and/or in the digital learning environment (Blackboard).
The student can view the room timetables of the classes for which he is registered via Osiris Student. The Student can also see in Osiris Student where and when the course tests for which he is registered will be held.

SECTION 4 – COURSES

Art. 4.1 – course

All courses that are part of the degree programmes have been included in the prospectuses for the programmes and can be found at the student site.

Art. 4.2 – course admission requirements

The Board of Studies will decide the order in which the required components of a Master's degree programme must be completed. This will be announced in the prospectus and/or the course guide.

Art. 4.3 – registration for courses

Participation in a course is possible only if the student has registered for it in good time. The Board of Studies will decide how and when registration takes place. Registration rules and closing dates will be published through the student site.

Art. 4.4 – attendance and effort requirements

1. Each student is expected to participate actively in the course for which he is registered.
2. Besides the general requirement for the student to participate actively in the course, the additional requirements for each component are listed in the University Course Catalogue and the course guide.
3. A student may be granted exemption from attendance for reasons demonstrably beyond his control (for instance as a result of illness or family circumstances), at the discretion of the course coordinator. The student must notify the study programme's secretariat of his absence in advance. The course coordinator or the Director of Education may request the student to provide written evidence of the exceptional circumstances.
4. In the event of qualitatively or quantitatively inadequate participation, the course coordinator may exclude the student from further participation in the course or part of it.
5. Effort requirements (such as holding a presentation or writing a paper) can never expire. If a student fails to meet an effort requirement in time for reasons beyond his control, the course coordinator will set a new date for the student to fulfil the obligation.
6. Students who wish to apply for special arrangements with regard to course obligations as a result of chronic illness, disability or Outstanding Student Athlete status, may submit a request to the Board of Examiners (see also Art. 7.3).

SECTION 5 – TESTING

Art. 5.1 – general

1. During the course, the student will be tested for academic schooling and on the extent to which he has sufficiently achieved the learning objectives set. The testing of the student will be concluded at the end of the course.
2. The University Course Catalogue and/or course guide describe the achievements the student must demonstrate to pass the course, as well as the criteria on which the student is assessed. In the event of a difference of opinion, the course guide will be followed.
3. If a course has to be repeated, the last classification gained will count.
4. Should a student pass a course, but still wishes to repeat the course, the complete course must be repeated.
5. The Regulations of the Board of Examiners describe the testing process (see: student site).

Art. 5.2 – Board of Examiners

1. The Dean will establish a Board of Examiners for each degree programme or group of degree programmes and will sufficiently ensure that the Board of Examiners can operate independently and professionally.
2. The Dean will appoint the chair and the members of the Board of Examiners for a period of three years on the basis of their expertise in the field of the degree programme(s) in question or the field of testing, in which:
   - at least one member comes from outside the degree programme or group of degree programmes concerned, and
   - at least one member is a lecturer on the degree programme or group of degree programmes concerned.

   Re-appointment is possible. Before making this appointment, the Dean will consult the members of the Board of Examiners concerned.
3. Persons holding management positions that include financial responsibilities or who are wholly or partially responsible for Master's degree programmes are not eligible for appointment to the Board of Examiners or as chair of the Board of Examiners. These persons will in any event include the Dean, the Vice Dean, directors/heads/managers of a department, members of a department's management/governing team, members or chairs of the Board of Studies of the Graduate or Undergraduate School and the Director of Education.
4. Membership of the Board of Examiners will end on completion of the term of appointment. The chair and members of the Board may also be dismissed by the Dean at their own request. The chair and members of the Board will be dismissed by the Dean if they no longer meet the requirements of paragraphs 2 or 3 of

this article. The Dean may also dismiss a chair or members found to be performing their statutory duties unsatisfactorily.

5. The Dean will announce the composition of the Board(s) of Examiners to students and lecturers.

Art. 5.3 – assessment of traineeship or research assignment and thesis

1. A traineeship or research assignment will be assessed by the supervisor in question and one or more other internal and/or external experts.
2. Master's theses will be assessed by at least two examiners.

Art. 5.4 – grades

1. Grades will be awarded on a scale of 1 to 10. The final assessment of a course is either pass or fail, expressed in numbers: 6 or higher and 5 or lower respectively.
2. The final course grade will be rounded to one decimal place. A partial course grade will never be rounded.
3. The final course grade of 5 will not have any decimal places. An average grade of 4.95 to 5.49 is a fail (5); an average grade of 5.50 to 5.99 is a pass (6).
4. The course guide sets out the way in which the final course grade is calculated.
5. Alphanumeric results are awarded in the following cases:
   - a student who is registered for a course and has not participated in one of the test modules will be given an NV (Niet Verschenen – No Show). If non-participation is for reasons beyond the student's control the student will be given an ND (Niet Deelgenomen– Not Participated);
   - a student who has not participated in all the test modules will be given an NVD (Niet VolDaan – Incomplete);
   - if the student has completed a module, but has not received a grade for it, he may be given a V (Voldoende – Satisfactory) as the result;
   - if the student has not completed a module but does not receive a grade for it, the student can be given an ONV (ONVoldoende - Unsatisfactory) as the result;
   - a student who has been granted exemption by the Board of Examiners will be given a VR (VRijstelling – Exemption);
   - if the Board of Examiners establishes fraud, the student may be given an FR (FRaude – Fraud) as the result.

Art. 5.5– repeat exams: supplementary or replacement tests

1. If during the course the student satisfies all the effort requirements and does not receive a pass grade but does receive a final grade of at least 4.00 before rounding, he will be given a once-only opportunity to take a supplementary test.
2. The lecturer will determine the form and content, as well as date and time, of the supplementary test.
3. If the student passes the individual supplementary test, a final grade of 6 for the entire course will be recorded in the student progress administration system. Partial course grades that the student has achieved will not be taken into account in establishing the final grade of the supplementary test.
4. If the student does not pass the supplementary test, the initial final grade will be entered into the student progress administration system, thus rendering all partial course grades no longer valid.
5. Students who miss a test or part of a test owing to circumstances demonstrably beyond their control will be given only one opportunity to sit a replacement test. Only students reporting these circumstances beyond their control immediately after their occurrence to the study programme's secretariat will be eligible to sit a replacement test.
6. The lecturer will determine the form and content of the replacement test.
7. If the student is not present at the replacement test, or fails to meet the terms of the replacement test in good time, he will not be offered another opportunity.

Art. 5.6 – type of test

1. Testing as part of a course will take place as stated in the course guide.
2. Upon request, the Board of Examiners may allow a test to be administered in a manner which departs from the provisions of the first paragraph.

Art. 5.7 – oral tests

1. Only one person at a time may be tested orally, unless the Board of Examiners decides otherwise.
2. Oral tests will be administered in public, unless the Board of Examiners or the examiner in question has decided otherwise in a special case, or the student has objected to this.

Art. 5.8 – provision for testing in special cases

1. If not providing for an individual testing possibility would result in a 'special case of manifest unfairness', the Board of Examiners may decide to grant an individual testing possibility.
2. Requests for a special possibility to sit a test must be submitted to the Board of Examiners as soon as possible, together with supporting documentary evidence.

Art. 5.9 – time limit for grading tests

1. Within 24 hours of administering an oral test the examiner will determine the grade and provide the student with a written statement of the grade awarded.
2. The examiner will grade a written or differently administered test or partial test within 10 working days of the test date, and will provide the administrative office of the Faculty with the information necessary to provide the student with written or electronic proof of his grade.
3. If there is a third examiner, a new assessment period of 10 working days will commence, immediately following the first period of 10 working days. It is not possible to commence a new period following this second period.
4. Time frames for assessment do not apply during academic vacation periods.
5. The written statement of the grade awarded must inform the student of the right of inspection referred to in Art. 5.11 and of the possibility to appeal to the Examination Appeals Board.

Art. 5.10 – period of validity

1. The term of validity of courses passed is eight years.
2. Notwithstanding this, in case of special circumstances the Board of Examiners may, if the student requests, determine an extended validity period for a course, or impose a supplementary or replacement test.
3. Partial tests and assignments passed in a course that was not successfully completed will expire at the end of the academic year in which they were passed. Partial tests and assignments expire at the end of the period in which they were passed, if the course concerned is taught more than once per academic year.

Art. 5.11 – right of inspection

1. Within 30 days after the announcement of the result of a written test, the student is allowed to inspect his graded work upon request. A copy of that work will be supplied to the student on request.
2. During the period referred to in the first paragraph, any interested party may inspect the questions and assignments of the test concerned, as well as, if possible, the standards on which the grade was based.

Art. 5.12 – retention of tests

1. The assignments, answers and the work assessed in the written tests will be kept in paper or electronic form for a period of two years following the assessment.
2. The thesis and its assessment will be kept in paper or electronic form for a period of seven years following the assessment.

Art. 5.13 – exemption

At the student's request, the Board of Examiners may, after consulting the examiner in question, grant the student exemption from a programme component if he:

a. has already either completed a university or higher vocational programme component which is equivalent in content and level; or
b. has demonstrated through work or professional experience that he has sufficient knowledge and skills in relation to that component.

Art. 5.14 – fraud and plagiarism

1. Fraud and plagiarism are defined as an action or failure to act on the part of a student, as a result of which a correct assessment of his knowledge, understanding and skills is made impossible, in full or in part.
   Fraud includes:
   - cheating during examinations. The person offering the opportunity to cheat is an accessory to fraud;
   - having within reach tools and resources during examinations, such as a pre-programmed calculator, mobile phone, smartwatch, smartglasses, books, course readers, notes, etc., consultation of which is not explicitly permitted;
   - having others carry out all of part of an assignment and passing this off as own work;
   - gaining access to questions, assignments or answers of an examination prior to the date or time that the examination takes place;
   - making up survey or interview answers or research data.

   Plagiarism is defined as including data or sections of text from others in a thesis or other paper without quoting the source. Plagiarism includes the following:
   - cutting and pasting text from digital sources such as encyclopaedias and digital magazines without using quotation marks and referring to the source;
   - cutting and pasting text from the internet without using quotation marks and referring to the source;
   - using excerpts from texts of printed material such as books, magazines and encyclopaedias without using quotation marks and referring to the source;

- using a translation of the abovementioned texts without using quotation marks and referring to the source;
- paraphrasing of the abovementioned texts without clearly referring to the source: paraphrasing must be marked as such (by explicitly linking the text with the original author, either in text or a footnote), so that the impression is not created that the ideas expressed are those of the student;
- using visual, audio or test material from others without referring to the source and presenting this as own work;
- resubmission of the student's own earlier work without referring to the source, and allowing this to pass for work originally produced for the purpose of the course, unless this is expressly permitted in the course or by the lecturer;
- using the work of other students and passing this off as own work. If this happens with the permission of the other student, the latter is also guilty of plagiarism;
- in the event that, in a joint paper, one of the authors commits plagiarism, the other authors are also guilty of plagiarism, if they could or should have known that the other was committing plagiarism;
- submitting papers obtained from a commercial institution (such as an internet site offering excerpts or papers) or having such written by someone else whether or not in return for payment.

2. a. In all cases in which fraud or plagiarism is found or suspected, the examiner will inform the student and the Board of Examiners of this in writing.
   b. The Board of Examiners will give the student the opportunity:
      - to respond to that in writing;
      - to be heard.
3. The Board of Examiners will determine whether fraud or plagiarism has occurred and will inform the student of its decision in writing and of the sanctions in accordance with the stipulations of the fourth paragraph, stating the possibility of appeal to the Examination Appeals Board.
4. Fraud and plagiarism will be punished by the Board of Examiners as follows:
   a. In any event:
      - invalidation of the paper or examination submitted
      - a reprimand, a note of which will be made in OSIRIS.
   b. In addition, – depending on the nature and scale of the fraud or plagiarism, and on the student's phase of study – one or more of the following sanctions:
      - removal from the course
      - no longer being eligible for a positive degree classification (cum laude) as referred to in art. 6.2
      - exclusion from participation in examinations or other forms of testing belonging to the educational component concerned for the current academic year, or for a period of 12 months
      - complete exclusion from participation in all examinations or other forms of testing for a period of 12 months.
   c. In the event that the student has already received a reprimand: complete exclusion from participation in all examinations or other forms of testing for a period of 12 months.
   d. In the case of extremely serious and/or repeated fraud, the Board of Examiners may recommend that the Executive Board permanently terminate the student's registration for the degree programme.
5. If the Board of Examiners determines that there has been widespread or organised fraud, on a scale which would affect the examination results in their entirety, the Board of Examiners will decide without delay that the examination concerned is invalid and that all the participants must resit the whole examination at short notice. The Board of Examiners will set the date on which the examination must be retaken. This date will be no later than two weeks after the fraud was established, so that the participants can still benefit from their preparatory work for the examination.

Art. 5.15 – right of appeal

The student has a right to appeal decisions taken by the Board of Examiners or by examiners. The appeal must be made in writing, and explaining the basis for the appeal, to the Examination Appeals Board within six weeks of taking the test or examination, or of the decision being made, pursuant to Section 7.61 of the Higher Education Research Act 1992.

SECTION 6 – EXAMINATION

Art. 6.1 – examination

1. As soon as a student has fulfilled the requirements of the examinations programme, the Board of Examiners will determine the result of the examination and award a certificate, as described in Art. 6.4.
2. Prior to determining the result of the examination, the Board of Examiners may conduct its own examination of the student's knowledge of one or more components or aspects of the degree programme, if and in so far as the results of the relevant tests give it reason to do so.
3. Assessment of the examinations file constitutes part of the final examination. The date of examination will be the last working day of the month in which the Board of Examiners has determined that the student has fulfilled all the requirements of the examinations programme.
4. Conditions to pass the examination are

- all components are passed;
- the composition of the course package completed meets the level requirements set.

5. A further condition for passing the examination and receiving the certificate is that the student was registered for the degree programme during the period in which the tests were taken. If the student does not fulfil this condition, the Executive Board may issue a statement of no objection in relation to the passing of the examination and the issue of the certificate, after the student has paid the tuition fees and administration charges owing for the 'missing' periods.
6. A student who has passed the examination and is entitled to a certificate may request the Board of Examiners to not yet grant the certificate and to postpone the examination date referred to in paragraph 3. This request has to be submitted within two weeks after the student has been informed of the result of the examination. The student will indicate in this request when he does wish to receive the certificate. The Board of Examiners will grant the request in any case if the student:
   - is to fulfil a management position for which Utrecht University has provided an administrative grant
   - is to do a traineeship or take a component of a programme abroad.

   The Board of Examiners may also grant the request if refusal would result in an exceptional case of extreme unfairness on account of the circumstance the the student concerned could not have taken automatic graduation into account when he was planning his study.
7. After the student has passed the final examination he can request the institution to terminate his registration.

Art. 6.2 – cum laude classification

1. If a student has demonstrated outstanding academic achievement in his Master's degree programme, the degree will be awarded cum laude; this classification will be noted on the degree certificate.
2. The cum laude classification will be awarded to the Master's examination if each of the following conditions have been met:
   1. the weighted average (based on EC) of the grades achieved for the Master's programme components is at least 8.00.
   2. the student has received a minimum grade of 8.00 for the Master's thesis.
   3. the student has been granted no more than 7.5 credits in exemptions that do not count towards the examination programme (1-year programmes) or no more than 15 credits (2-year programmes).
   4. there has been no decision by the Board of Examiners (as referred to in Art. 5.14) that because it has been established that fraud/plagiarism has been committed the student no longer qualifies for a positive classification (cum laude).
   5. the Master's examination has been passed within one and a half years (one-year degree programmes) or three years (two-year degree programme).
3. The Board of Examiners may decide to award the cum laude classification even if not all the requirements referred to in paragraph 2 are met. Such a decision must be unanimous.
4. Classifications other than cum laude will not be noted on the degree certificate.

Art. 6.3 – degree

1. The Master of Science degree will be awarded to the student who passes the examination.
2. The degree awarded will be noted on the examination certificate.

Art. 6.4 – degree certificate

1. The Board of Examiners will award a certificate as proof that the examination was passed.
2. The Board of Examiners will add the International Diploma Supplement to the certificate which provides (international) insight into the nature and contents of the completed degree programme.

Art. 6.5 - Grade Point Average (GPA)

1. The final Grade Point Average (GPA) is stated on the International Diploma Supplement, and represents the academic performance of the student concerned.
2. The final GPA is the average figure from the results achieved in the examinations programme for the Master's degree, weighted by course credits and expressed on a scale of 1 to 4 with two decimals.
3. The final GPA is calculated as follows:
   - all applicable examinations achieved as part of the examinations programme for the Master's degree are converted into quality points;
   - quality points are the applicable examination result multiplied by the number of course credits (EC) for the component in question;
   - the total number of quality points achieved divided by the total number of course credits (EC) obtained, gives the average examination result;
   - the average examination result is converted into the final GPA.

SECTION 7 – STUDENT COUNSELLING

Art. 7.1 – student progress administration

1. The Faculty must record the individual study results of the students and make them available through Osiris-student.
2. Certified student progress files may be obtained from Student Affairs Geosciences.

Art. 7.2 – student counselling

1. The Faculty is responsible for providing an introductory programme and student counselling to students registered for the degree programmes.
2. Student counselling encompasses:
    - encouraging students to feel part of the community;
    - supervising programme choices;
    - assisting a student to familiarise himself with the job market.
    - an introductory programme in the first week of the first semester of the first year of study
    - referring and assisting students who encounter difficulties during their studies.

Art. 7.3 – disability

Students with special needs are afforded the opportunity to take classes and sit tests in the manner agreed in their special needs contracts. Requests for special needs contracts are submitted to the student advisor.

SECTION 8 – TRANSITIONAL AND FINAL PROVISIONS

Art. 8.1 – safety net arrangements

In cases for which these Regulations do not provide, do not clearly provide or lead to obviously unreasonable outcomes, a decision will be taken by or on behalf of the Dean, after having heard the Board of Examiners. If, on the basis of the law, the decision falls within the competence of the Board of Examiners, the Dean will send the request to the Board of Examiners for it to settle.

Art. 8.2 – amendments

1. Amendments to these Regulations will be laid down by the Dean after having heard the Degree Programme Committee and after consultation with the Faculty Council, in separate resolutions.
2. An amendment to these Regulations is not to be applied to the current academic year, unless it is reasonable to assume that it will not harm the interests of the students.
3. Furthermore, an amendment may not have an adverse effect for students on any other decision the Board of Examiners has taken pursuant to these Regulations with respect to a student.

Art. 8.3 – publication

The Dean will provide for the publication of these Regulations, as well as each amendment, on the internet.

Art. 8.4 – effective date

These Regulations take effect on 1 September 2016.

APPENDIX 1 Admission requirements Master's degree programmes

Earth, Life and Climate
Admission to the programme Earth, Life and Climate is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Earth Sciences, Biology or Chemistry, at advanced level of the major Earth Sciences, Biology or Chemistry at Utrecht University, or equivalent to that level.
b) insight in Earth Sciences at advanced level of the major Earth Sciences, Biology or Chemistry at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Earth Sciences, Biology or Chemistry at Utrecht University, or equivalent to that level.

Earth Structure and Dynamics
Admission to the programme Earth Structure and Dynamics is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Earth Sciences or Physics, at advanced level of the major Earth Sciences or Physics at Utrecht University, or equivalent to that level.
b) insight in Earth Sciences at advanced level of the major Earth Sciences or Physics at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Earth Sciences or Physics at Utrecht University, or equivalent to that level.

Earth Surface and Water
Admission to the programme Earth Surface and Water is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills on a university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Earth Sciences, at advanced level of the major Earth Sciences at Utrecht University, or equivalent to that level.
b) insight in Earth Sciences at advanced level of the major Earth Sciences at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Earth Sciences at Utrecht University, or equivalent to that level.

Economische Geografie (Economic Geography)
Admission to the programme Economische Geografie is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Economische Geografie, at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
b) insight in Economische Geografie at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Human Geography and Planning at Utrecht University, or equivalent to that level.

Energy Science
Admission to the programme Energy Science is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Environmental Sciences, Science and Innovation Management, Physics or Chemistry at advanced level of the major Environmental Sciences, Science and Innovation Management, Physics or Chemistry at Utrecht University, or equivalent to that level.
b) knowledge of Thermodynamics, Energy Analysis and Mathematics
c) insight in Environmental Sciences, Science and Innovation Management, Physics or Chemistry at advanced level of the major Environmental Sciences, Science and Innovation Management, Physics or Chemistry at Utrecht University, or equivalent to that level.
d) academic and research skills of the major Environmental Sciences, Science and Innovation Management, Physics or Chemistry at Utrecht University, or equivalent to that level.

Geo-communicatie (Geo-communication)
Admission to the programme Geo-communicatie is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Human or Physical Geography, at advanced level of the major Human Geography and Planning or Earth Sciences at Utrecht University, or equivalent to that level.

b) insight in Human or Physical Geography at advanced level of the major Human Geography and Planning or Earth Sciences at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Human Geography and Planning or Earth Sciences at Utrecht University, or equivalent to that level.

GIMA (Master of Science in Geographical Information Management and Applications)
Admission to the programme Geographical Information Management and Applications is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, understanding and skills at university Bachelor's level, for instance equivalent to the advanced level of the major Human Geography and Planning at Utrecht University:

a) knowledge in the field of geo-information, geography, GIS or another GIMA related field of study.
b) insight in geographical data processes and collecting, processing and distributing information.
c) Academic skills and research skills.

Innovation Sciences
Admission to the programme Innovation Sciences is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Science and Innovation Management, Natural Sciences or Life Sciences, at advanced level of the major Science and Innovation Management, Natural Sciences or Life Sciences at Utrecht University, or equivalent to that level.
b) knowledge in the field of emerging technology issues and complex multidisciplinary problems.
c) insight in Science and Innovation Management, Natural Sciences or Life Sciences, at advanced level of the major Science and Innovation Management, Natural Sciences or Life Sciences at Utrecht University, or equivalent to that level.
d) academic and research skills of the major Science and Innovation Management, Natural Sciences or Life Sciences at Utrecht University, or equivalent to that level.

International Development Studies
Admission to the programme International Development Studies is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Development Geography, at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
b) insight in Development Geography at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Human Geography and Planning at Utrecht University, or equivalent to that level.

Marine Sciences
Admission to the programme Marine Sciences is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Earth Sciences or Biology, at advanced level of the major Earth Sciences or Biology at Utrecht University, or equivalent to that level.
b) insight in Earth Sciences or Biology at advanced level of the major Earth Sciences or Biology at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Earth Sciences or Biology at Utrecht University, or equivalent to that level.

Spatial Planning
Admission to the programme Spatial Planning is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Planning, at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
b) insight in Planning at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Human Geography and Planning at Utrecht University, or equivalent to that level.

Sustainable Business and Innovation
Admission to the programme Sustainable Business and Innovation is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Science and Innovation Management, Environmental Sciences, Environmental Studies or Economics, at advanced level of the major Science and Innovation Management, Environmental Sciences, Environmental Studies or Economics at Utrecht University, or equivalent to that level.
b) knowledge of sustainable development and/or innovation sciences.
c) basic knowledge of natural sciences at Bachelor's level, including Mathematics, and/or Chemistry and/or Physics.
d) insight in Science and Innovation Management, Environmental Sciences, Environmental Studies or Economics at advanced level of the major Science and Innovation Management, Environmental Sciences, Environmental Studies or Economics at Utrecht University, or equivalent to that level.
e) academic and research skills of the major Science and Innovation Management, Environmental Sciences, Environmental Studies or Economics at Utrecht University, or equivalent to that level.

Sustainable Development
Admission to the programme Sustainable Development is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Environmental Sciences, Natural Sciences or Social Sciences at the advanced level of a major in Earth Sciences, Physics, Chemistry, Biology, Economics, Public Administration and Organisation Science or Social Sciences at Utrecht University, or equivalent to that level.
b) knowledge in the field of sustainability issues.
c) basic knowledge of physical processes in the environment
d) basic knowledge of mathematics at bachelor's level
e) insight in Environmental Sciences, Natural Sciences or Social Sciences at the advanced level of a major in Earth Sciences, Physics, Chemistry, Biology, Economics, Public Administration and Organisation Science or Social Sciences at Utrecht University, or equivalent to that level.
f) academic and research skills of a major in Earth Sciences, Physics, Chemistry, Biology, Economics, Public Administration and Organisation Science or Social Sciences at Utrecht University, or equivalent to that level.

Urban and Economic Geography (Research Master)
Admission to the research programme Human Geography and Planning is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Human Geography or Spatial Planning, at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
b) insight in Human Geography or Spatial Planning at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Human Geography and Planning at Utrecht University, or equivalent to that level.

Urban Geography
Admission to the programme Urban Geography is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Urban Geography, at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
b) insight in Urban Geography at advanced level of the major Human Geography and Planning at Utrecht University, or equivalent to that level.
c) academic and research skills of the major of Human Geography and Planning at Utrecht University, or equivalent to that level.

Water Science and Management
Admission to the programme Water Science and Management is given to a student holding a Dutch or foreign diploma confirming that he has gained the knowledge, insights and skills at university Bachelor's level. Furthermore, the student needs to prove that he has gained the following specific knowledge, insights and skills:

a) knowledge in the field of Earth Sciences, Environmental Sciences or Natural Sciences, at advanced level of the major Earth Sciences or Environmental Sciences at Utrecht University, or equivalent to that level.
b) insight in Earth Sciences, Environmental Sciences or Natural Sciences at advanced level of the major Earth Sciences or Environmental Sciences at Utrecht University, or equivalent to that level.
c) academic and research skills of the major Earth Sciences or Environmental Sciences at Utrecht University, or equivalent to that level.

APPENDIX 2 Structure of Master's degree programmes

Earth, Life and Climate

Theoretical courses: required electives	45 EC
Deficiency courses	0-15 EC
MSc research/thesis	30-45 EC
Individual programme/ internship Obligatory 2nd report	up to 30 EC
Additional theoretical courses, seminar modules, advanced-level courses	0- 45 EC

Earth Structure and Dynamics

Theoretical courses: required electives	45 EC
Deficiency courses	0-15 EC
MSc research/thesis	30-45 EC
Individual programme/ internship Obligatory 2nd report	up to 30 EC
Additional theoretical courses, seminar modules, advanced-level courses	0- 45 EC

Earth Surface and Water

Theoretical courses: required electives	45 EC
Deficiency courses	0-15 EC
MSc research/thesis	30-45 EC
Individual programme/ internship Obligatory 2nd report	up to 30 EC
Additional theoretical courses, seminar modules, advanced-level courses	0- 45 EC

Economische Geografie

Required / theoretical	22.5 EC
Methods of research	7.5 EC
MSc research/thesis	30 EC

Energy Science

Required / theoretical	22.5 EC
Methods of research	15 EC
MSc thesis / internship	30 – 52.5 EC
Elective	22.5 – 37.5 EC

Geo-communicatie

Required / theoretical	30 EC
Individual project/ internship	7.5- 15 EC
MSc research/thesis	15-22.5 EC

Geographical Information Management and Applications

Required / theoretical	40 EC
Required (practical methods)	20 EC
MSc research/thesis	30 EC
Internship or Individual programme	30 EC

International Development Studies

Required / theoretical	20 EC
Methods of research	10 EC
MSc research/thesis	30 EC

Marine Sciences

Theoretical courses	45 EC
Elective courses	15-30 EC
MSc research / thesis / individual programme / internship Obligatory 2nd report	30-45 EC 15-30 EC

Innovation Sciences

Required / theoretical	37.5 EC
Methods of research	22.5 EC
MSc research/thesis	45 EC
Elective	15 EC

Spatial Planning

Required / theoretical	22.5 EC
Methods of research	7.5 EC
MSc research/thesis	30 EC

Sustainable Development

Required / theoretical	45 EC
Methods of research	15 EC
MSc research/thesis	30-45 EC
Elective	15-30 EC

Sustainable Business and Innovation

Required / theoretical	45 EC
Methods of research	15 EC
MSc thesis/ internship	45 EC
Elective	15 EC

Urban and Economic Geography

Required / theoretical	60 EC
Elective	15 EC
MSc research/thesis	45 EC

Urban Geography

Required / theoretical	22.5 EC
Methods of research	7.5 EC
MSc research/thesis	30 EC

Water Science and Management

Required / theoretical	75 EC
MSc research/thesis (obligatory external internship format)	30 - 45 EC
Elective / MSc individual programme	0 - 15 EC

Appendix III Teaching periods 2016-2017

This holds only for Master's courses offered by the department IEES (codes GEO4-22XX, 23XX, 25XX and 26XX); this might deviate from courses with other (GEO-)codes.

36	37	38	39	40	41	42	43	44	45
1 5/9-11/9	2 12-18/9	3 19-25/9	4 26/9-2/10	5 3-9/10	6 10-16/10	7 17-23/10	8 24-30/10	9 31/10-6/11	10 7-13/11
MSc GEO Intro									break

46	47	48	49	50	51	52	1	2	3	4	5
1 14-20/11	2 21-27/11	3 28/11-4/12	4 5-11/12	5 12-18/12	6 19-25/12	Xmas break	Study week	7 9-15/1	8 16-22/1	9 23-29/1	10 30/1-5/2
			6/12 rep. 1	13/12 rep. 1							break

6	7	8	9	10	11	12	13	14	15	16
1 6-12/2	2 13-19/2	3 20-26/2	4 27/2-5/3	5 6-12/3	6 13-19/3	7 20-26/3	8 27/3-2/4	9 3-9/4	10 10-16/4	11 17-23/4
9/2 UU Careerday			28/2 rep. 2	7/3 rep. 2					Friday 14/4 break	break
									14/4 Good Friday	17/4 Easter

17	18	19	20	21	22	23	24	25	26	27	28	29
1 24-30/4	2 1-7/5	3 8-14/5	4 15-21/5	5 22-28/5	6 29/5-4/6	7 5-11/6	8 12-18/6	9 19-25/6	10 26/6-2/7	11 3-9/7	Break	Break
27/4 King's day	5/5 Liberationday		16/5 rep. 3	23/5 rep. 3		5/6 Pentecost				break	10-13/7 rep. 4	
				25/5 Ascension day								
				26/5 break								

Green = IMEW (IEES)	Red = GEO wide

Appendix IV UU-time table 2016-2017

Teaching periods

Semester I:
Period 1: Monday 5 September – Friday 11 November
Period 2: Monday 14 November – Friday 3 February

Semester II:
Period 3: Monday 6 February – Friday 21 April
Period 4: Monday 24 April – Friday 14 July

Timeslots

A Monday morning and/or Wednesday morning
B Tuesday morning and/or Thursday afternoon
C Monday afternoon and/or Thursday morning
D Wednesday afternoon, Friday morning and/or Friday afternoon
E Monday evening, Tuesday evening, Wednesday evening, Thursday evening and/or Friday evening

Course registration (only via Osiris Student: www.uu.nl/osirisstudent)

- For period 1: 30 May 2016 up to and including 26 June 2016
  - late registration 22 and 23 August 2016
- For period 2: 19 September 2016 up to and including 2 October 2016
  - late registration 31 October and 1 November 2016
- For period 3: 31 October 2016 up to and including 27 November 2016
  - late registration 23 and 24 January 2017
- For period 4: 30 January 2017 up to and including 26 February 2017
  - late registration 3 and 4 April 2017
- For period 1, 2017-2018 (provisionally): 29 May 2017 up to and including 25 June 2017
  - late registration 21 and 22 August 2017