



M Energy Science
Utrecht University

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Project code P2304

Contents

Summary	4
Score table	6
Introduction.....	7
Procedure.....	7
Panel	8
Information on the programme	9
Description of the assessment.....	10
Organization	10
Previous accreditation's panel's recommendations.....	10
Standard 1. Intended learning outcomes	10
Standard 2. Teaching-learning environment.....	12
Standard 3. Student assessment	17
Standard 4. Achieved learning outcomes	19
Development points	20
Appendix 1. Intended learning outcomes	21
Appendix 2. Programme curriculum.....	22
Appendix 3. Programme of the site visit.....	23
Appendix 4. Materials	24

Summary

Standard 1. Intended learning outcomes

Based on the reviewed documents and discussions during the site visit, the panel concludes that the programme has a clear and unique profile, providing students with an interdisciplinary perspective and enabling them to analyze energy systems in an integrated manner. The panel appreciates the focus on the natural science and technical aspects of the energy transition and its societal challenges. It is also very positive about the comprehensive renewal of the programme and its ILOs done in close collaboration with the professional field, which will lead to a future proof programme that can adapt to the latest developments in the energy sector. Furthermore, the programme is highly responsive to contemporary academic and societal debates, due to its strong connections with the professional and societal field. The panel considers the ILOs to be appropriate to an academic master's level and in alignment with expectations in the academic and professional field.

Standard 2. Teaching-learning environment

The panel considers the curriculum to be well-structured and coherent. The curriculum covers all ILOs and provides students with a solid, interdisciplinary foundation in Energy Science, with a default track in System Analysis. Starting next academic year, only a single curriculum will be offered, with no separate tracks. However, students will keep ample opportunity to choose their own focus through an individual trajectory. The panel sees the focus on practice-based skills as a strong component of the programme, particularly in the integration courses linked with external organisations. The panel concludes that the development of academic and professional skills is sufficiently addressed in all courses. To further strengthen the coherence of skills development within the curriculum and make this more explicit to students, the panel suggests developing skills learning lines.

The panel appreciates how the curriculum is continually updated in response to developments in the professional and academic field. It is very positive about the recent renewal of the curriculum, which will also improve the alignment with other programmes in the department: to accommodate students, all electives will be offered in the same periods. The panel suggests the programme management could make it easier for students to take electives elsewhere by providing adequate guidance and information. In addition, the panel appreciates that the renewed programme will focus more on technical skills and that it will include a 45 EC master's thesis, with the option to do this in a company as a way to integrate an internship with research.

The panel values the student-centred learning environment, with the focus on small-group, interactive teaching and the high level of student involvement. According to the panel, there is adequate supervision, feedback and support. The courses offer varied teaching methods, including guest lectures to introduce students to different perspectives, projects based on real-life cases, and ample opportunity for peer learning. Moreover, the programme provides flexibility and freedom of choice for students in determining their study route and developing their own profile.

The feasibility of the programme is in order, although delays can occur during the thesis project. The panel noted differences in both duration of the thesis project and length of the theses. It urges the programme to expand the recently introduced rules for the duration of the master's thesis trajectory to include a guideline for the scope of the master's thesis. The panel also suggests including a guideline for the development of research methods/models. Students receive proper information and guidance during the programme, and sufficient extra guidance and support if needed. They appreciate the guidance offered by lecturers and study advisers and find them easily accessible.

The panel is impressed with the quality of the teaching staff. They are all didactically qualified and are experts in their field, covering the academic scope of the programme. The lecturers all combine teaching and research and have strong connections with the professional and societal field through their own research activities. Thus, the Copernicus Institute with its societal impact orientation provides an excellent research base and practical input for the programme. The alignment and cohesion of the curriculum and teaching team are ensured by regular meetings and calibration among staff members. The panel appreciates that the teaching staff has been expanded with 6 new staff members with a wide variety in scientific backgrounds. Thanks in part to the staff increase, the panel sees a positive trend with respect to teachers' perceived high workload, but recommends continued monitoring and evaluation of this workload.

The English-taught programme is internationally oriented, which is reflected in the international community of students and staff. According to the panel, the choice for an English name and language of instruction is well substantiated and in alignment with the international nature of the professional and academic field.

Standard 3. Student assessment

The panel concludes that the assessment system is transparent and well designed. Adequate procedures, such as the four-eyes principle, are in place to ensure and enhance the quality of assessment. The assessment methods used are diverse and appropriate, and include structural formative feedback. The panel appreciates the attention for the coherency of assessment and the strong culture of calibration among teachers, as well as the efforts to reduce the workload of teachers with regard to continuous assessment, and to realign the standard rubric forms. The panel is also positive about group work monitoring. There is a good balance between individual and group assignments, with sufficient attention to skills. In addition, the panel advises the programme to establish uniform rules for preparatory exams. To communicate these clearly to students, the panel recommends including more detailed information in the course guides.

The master's thesis covers all ILOs of the programme at an individual level and is always independently assessed by two examiners. The panel considers the thesis assessment procedure to be well thought out. According to the panel, the grades awarded are sufficiently substantiated. There are regular calibration sessions around assessment, with subsequent adjustments as needed, such as the recent modification of the assessment forms.

According to the panel, the Board of Examiners proactively contributes to the quality of assessment in the programme. It safeguards the quality of assessment in the programme in various ways, including the continuous investigation of potential vulnerabilities in the assessment of courses. In particular, the panel appreciates the recent evaluation of the rubrics and the elaborated proposal for a peer review process to encourage alignment between courses and course assessments.

Standard 4. Achieved learning outcomes

The panel concludes that the level of the theses is appropriate for an academic master's programme. The theses demonstrate the achievement of the ILOs. The documentation and interviews show that alumni are generally content about the programme and are well prepared to perform successfully in the professional field.

Score table

The panel assesses the programme as follows:

Master's programme Energy Science

Standard 1: Intended learning outcomes

meets the standard

Standard 2: Teaching-learning environment

meets the standard

Standard 3: Student assessment

meets the standard

Standard 4: Achieved learning outcomes

meets the standard

General conclusion

positive

Em. prof. dr. J.T.A. (Hans) Bressers, panel chair

C. (Carlijn) Braam, panel secretary

Date: 20 September 2024

Introduction

Procedure

Assessment

On 18 and 19 June 2024, the master's programme Energy Science of Utrecht University was assessed by an independent peer review panel as part of the cluster assessment Environmental Sciences. The assessment cluster consisted of 17 programmes, offered by the institutions Open University, University of Amsterdam, Wageningen University, Delft University of Technology, Radboud University, Vrije Universiteit Amsterdam, University of Groningen, Maastricht University, Leiden University, and Utrecht University. The assessment followed the procedure and standards of the NVAO Assessment Framework for the Higher Education Accreditation System of the Netherlands (September 2018).

Quality assurance agency Academion coordinated the assessment upon request of the cluster Environmental Sciences. Peter Hilderling and Jessica van Rossum acted as coordinator and as panel secretaries. Annemarie Venemans, Esther Poort, Anne-Lise Kamphuis, Linda te Marvelde, Carlijn Braam and Jessica van Rossum also acted as secretaries in the cluster assessment. They have been certified and registered by the NVAO. Carlijn Braam acted as panel secretary in the assessment of the master's programme Energy Science of Utrecht University.

Preparation

Academion composed the peer review panel in cooperation with the institutions and taking into account the expertise and independence of the members as well as consistency within the cluster. On 15 December 2023, the NVAO approved the composition of the panel. The coordinator instructed the panel chair on his role in the site visit according to the Panel chair profile (NVAO 2016).

The programme composed a site visit schedule in consultation with the coordinator (see appendix 3). The programme selected representative partners for the various interviews. It also determined that the development dialogue would be made part of the site visit. A separate development report was made based on this dialogue.

The programme provided the coordinator with a list of graduates over the period October 2021 – August 2023. In consultation with the coordinator, the panel chair selected 15 theses. They took the diversity of final grades and examiners into account. Prior to the site visit, the programme provided the panel with the theses and the accompanying assessment forms. It also provided the panel with the self evaluation report and additional materials (see appendix 4).

The panel members studied the information and sent their findings to the secretary. The secretary collected the panel's questions and remarks in a document and shared this with the panel members. In a preliminary meeting, the panel discussed the initial findings on the self-evaluation report and the theses, as well as the division of tasks during the site visit. The panel was also informed on the assessment framework, the working method and the planning of the site visits and reports.

Site visit

During the site visit, the panel interviewed various programme representatives (see appendix 3). The panel also offered students and staff members an opportunity for confidential discussion during a consultation

hour. No consultation was requested. The panel used the final part of the site visit to discuss its findings in an internal meeting. Afterwards, the panel chair publicly presented the preliminary findings.

Report

The secretary wrote a draft report based on the panel's findings and submitted it to the coordinator for peer assessment. Subsequently, the secretary sent the report to the panel for feedback. After processing this feedback, the secretary sent the draft report to the programme in order to have it checked for factual irregularities. The secretary discussed the ensuing comments with the panel chair and changes were implemented accordingly. The panel then finalized the report, and the coordinator sent it to the Faculty of Geosciences of Utrecht University.

Panel

The following panel members were involved in the cluster assessment Environmental Sciences:

- Em. prof. dr. J.T.A. (Hans) Bressers, emeritus professor in Policy Studies and Environmental Policy at the University of Twente (chair);
- Prof. dr. A.C. (Arthur) Petersen, professor in Science, Technology and Public Policy at the University College London (United Kingdom);
- Dr. A.R. (Ana) Vasques, lecturer at the Erasmus University College of Erasmus University Rotterdam;
- Dr. S.E. (Sarah) Cornell, associate professor at the Stockholm Resilience Centre of Stockholm University (Sweden);
- Em. prof. dr. M.C. E. (Rietje) van Dam-Mieras, emeritus professor in Sustainable Development and Innovation of Education at Leiden University, and member of the Top Consortium for Knowledge and Innovation (TKI) Biobased Circular (focus Human Capacity Agenda);
- Dr. ir. T. (Thijs) Bosker, associate professor in Environmental Sciences at Leiden University;
- Prof. dr. ir. S.E. (Siegfried) Vlaeminck, professor in Microbial Cleantech and Environmental Systems Analyses at the Universiteit of Antwerpen (Belgium);
- Prof. dr. M.P.J. (Maarten) Loopmans, professor in Human Geography and Political Ecology at the KU Leuven (Belgium);
- Dr. ir. S.G. (Gerd) Weitkamp, associate professor in Health Geography, Mobility, and Geospatial Technologies at the University of Groningen;
- Prof. dr. P. (Paquita) Perez Salgado, professor in Natural Sciences at the Open Universiteit Nederland;
- Prof. dr. E. (Esther) Turnhout, professor in Science, Technology and Society at the University of Twente;
- Em. prof. dr. ir. J.T. (Hans) Mommaas, emeritus professor in Regional Sustainability Governance at Tilburg University, and chair of the Ecological Authority;
- Dr. P. (Patricia) de Cocq, director Nature & Society at HAS green academy;
- Prof. dr. ir. Z. (Zofia) Lukso, professor in Smart Energy Systems at the Delft University of Technology;
- M. M. (Marisa) Beunk MSc., alumni (March 2023) of the master's programme Environmental Sciences (Policy Track) of Wageningen University (student member);
- F.O. (Fenna) Oostrum, alumni (September 2023) of the master's programme Environment and Society Studies of Radboud University (student member).

The panel assessing the master's programme Energy Science at Utrecht University consisted of the following members:

- Em. prof. dr. J.T.A. (Hans) Bressers, emeritus professor in Policy Studies and Environmental Policy at the University of Twente (chair);
- Prof. dr. A.C. (Arthur) Petersen, professor in Science, Technology and Public Policy at the University College London (United Kingdom);

- Dr. P. (Patricia) de Cocq, director Nature & Society at HAS green academy;
- Prof. dr. ir. Z. (Zofia) Lukszo, professor in Smart Energy Systems at the Delft University of Technology;
- F.O. (Fenna) Oostrum, alumni (September 2023) of the master's programme Environment and Society Studies of Radboud University (student member).

Information on the programme

Name of the institution:	Utrecht University
Status of the institution:	Publicly funded institution
Result institutional quality assurance assessment:	Positive
Programme name:	Energy Science
CROHO number:	60967
Level:	Master
Orientation:	Academic
Number of credits:	120 EC
Specializations or tracks:	Systems Analysis and Natural Science
Location:	Utrecht
Mode(s) of study:	Fulltime
Language of instruction:	English
Submission date NVAO:	1 November 2024

Description of the assessment

Organization

The master's programme Energy Science started in 2005. Since its development, there have been several changes in the embedding of the programme as well as in the staff involved. Initially, it was part of the master's programme Science & Business in the Science Faculty. In 2013, it became a specialization within the Science and Innovation master's programme in the Faculty of Geosciences. In 2021, the programme obtained its own CROHO label. The programme is embedded in the Graduate School of Geosciences and is organized by the Department of Sustainable Development.

Previous accreditation's panel's recommendations

The last formal external assessments of the master's programme Energy Science of Utrecht University took place in 2017, as part of the Science and Innovation master's programme and in 2019, when it obtained its own CROHO label. In 2019, the panel set the condition to develop a plan of action with regard to how the programme will guarantee adherence to the assessment procedures for the Master Thesis and to give account of the execution of this plan. The panel also gave several recommendations.

In the self-evaluation report of the current assessment, the programme described the actions undertaken in response to the recommendations. Also, several improvements were discussed in the interviews during the site visit. The improvements included establishing a more independent position and unique profile, intensifying the collaboration with the professional field, and conducting alumni surveys. The panel concludes that the recommendations have been seriously acted upon by the programme and is generally content with the improvement measures taken. For some recommendations, it became clear that the programme is still in the process of addressing these. These issues are points of attention in the renewal process and will be described further on in this report.

Standard 1. Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Findings

The master's programme Energy Science aims to educate students to become professionals who can contribute to the transition towards sustainable energy systems. The programme has an interdisciplinary character, integrating knowledge and methods from several natural and social sciences, and focuses on analysing energy systems in an integrated manner. Through its interdisciplinary perspective, the programme distinguishes itself both from energy-related programmes at technical universities, which have a more technology and engineering focus, and from general sustainable development and innovation related programmes, which have no specific focus on energy. The programme describes itself as mission- and solution-oriented and deeply rooted in society. It provides students with in-depth technological knowledge, strong analytical skills, research experience and a professional attitude that allow them to systematically address research questions and problems from the field of energy science.

The panel appreciates the unique profile of the interdisciplinary programme, with an emphasis on the natural science and technical aspects of the energy transition and its societal challenges. At the moment, the socio-economic context and aspects are considered to a limited extent. However, the panel was informed that these will receive more attention in the new curriculum to be implemented in the next academic year.

The panel endorses the fact that this component is being addressed in the renewal process of the programme. The programme clearly stimulates students to become well-trained professionals and to be sufficiently prepared to continue research at the PhD level. According to the panel, the programme is highly responsive to developments in the dynamic field and contemporary academic and societal debates, also through its strong connection with the Copernicus Institute.

The panel observed that the programme has a selective admissions procedure to ensure an optimal match for prospective students with the objectives and learning environment of the programme. Central to the admission requirements are research skills, knowledge and understanding of energy analysis, natural sciences, mathematics and technology, and a solid foundation in thermodynamics. The programme aims to attract students from both the Netherlands and abroad. Over the years, student numbers have fluctuated between 29 to 72 per year. Due to the rapid ongoing changes in the field of energy science, the programme has been working on an extensive renewal of the curriculum since 2022, with changes to be implemented in the academic year 2024-2025. The revision includes redefining the overall goal, the intended learning outcomes (ILOs), the structure and alignment of the curriculum, the content of the courses, and teaching and assessment methods. With this revision, the programme also aims to engage students, alumni, lecturers, researchers and societal partners in an inspiring collaborative community. The panel is very positive about the renewal of the programme, and the new overall aim to educate students to become professionals who can take a leading role in the energy transition from an integrated energy systems perspective. The renewal of the programme is also intended to increase student numbers, by reconsidering the admission requirements and communication strategy.

Intended learning outcomes

In accordance with the new overall aim and in line with the Dublin Descriptors and the domain-specific framework, the ILOs are being reformulated in such a way that they will be future proof and less overlapping. The panel appreciates that input from the professional field is explicitly taken into account in the revision process, meeting the recommendation of the previous accreditation panel to consult with the professional field more systematically and explicitly. Consequently, programming will be part of the new curriculum, for example. At the same time, by defining the new ILOs at a fairly general and abstract level, they will provide room to adapt the curriculum to the latest developments, as the knowledge and skills required are subject to change.

The panel considers the current ILOs to be appropriate for the academic master's level. They are in accordance with the Dublin Descriptors and the domain-specific framework, and cover all relevant aspects of the master's programme. According to the panel, the programme is well-connected to the professional field and society as there are many interactions in the context of internships, research projects of teaching staff, guest lectures, activities and the strong network of the study association NRG and contacts with alumni. Further alignment with the field is pursued through the Societal Advisory Board. The panel was pleased to learn that the Advisory Board is involved in the development of the programme, and advises it on developments within the domain as well as the needs of society and the professional field that are relevant to the content of the programme.

Considerations

Based on the reviewed documents and discussions during the site visit, the panel concludes that the programme has a clear and unique profile, providing students with an interdisciplinary perspective and enabling them to analyze energy systems in an integrated manner. The panel appreciates the focus on the natural science and technical aspects of the energy transition and its societal challenges. It is also very positive about the comprehensive renewal of the programme and its ILOs done in close collaboration with

the professional field, which will lead to a future proof programme that can adapt to the latest developments in the energy sector. Furthermore, the programme is highly responsive to contemporary academic and societal debates, due to its strong connections with the professional and societal field. The panel considers the ILOs to be appropriate to an academic master's level and in alignment with expectations in the academic and professional field.

Conclusion

The panel concludes that the programme meets standard 1.

Standard 2. Teaching-learning environment

The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Findings

Curriculum

The programme consists of 120 EC and is offered as a fulltime two-year programme. The curriculum includes courses on interdisciplinary context, science and technology, energy systems analysis, and integration courses where students can put their knowledge and skills into practice with real-world assignments, often in collaboration with external organizations. The programme aims to take both a research-based and a student-centred approach. The default track of the programme is the System Analysis track, which the large majority of students follow. In this track, the first year consists of seven courses (60 EC, of which 7.5 EC are elective). In these courses, students are trained in the fundamental natural sciences of energy technologies, energy system analyses, energy systems modelling and the societal context of energy systems. They apply the obtained knowledge and skills to societal challenges in the integration course (the consultancy project, 15 EC), where students work in teams on a project of their preference. The course includes a tutorial about roles in group work, weekly meetings with a supervisor and a mid-course reflection moment with the teams. In the second year, students follow an individual trajectory, consisting of a combination of electives (15-30 EC), which may include an internship (15 or 22.5 EC), and the master's thesis (30 or 45 EC). During the internship, students work on a project focusing on an energy-related problem at a host organization, under the guidance of a programme supervisor and a supervisor at the host organization. The programme has a growing network with organizations, including through the study association NRG.

7

Until 2023-2024, students also had the option to follow a Natural Science track, which shared six courses (45 EC) with the default System Analysis track but puts more emphasis on the fundamental physics of energy technologies. Key components of the Natural Sciences track were two natural science oriented elective courses (15 EC) and the Natural Sciences Research Project (30 EC) instead of the consultancy project and an optional internship. Only a few students per year enrolled in the Natural Science track. The new curriculum will not have different tracks, and students have ample opportunity to choose a more natural science-oriented path. Students can further develop their knowledge and skills in interdisciplinary settings by participating in extracurricular programmes, such as the Young Innovators Programme.

The panel considers the curriculum to be well-structured and coherent, with strong links between the courses. The curriculum covers all ILOs, as is demonstrated in the tables included in the self-evaluation report. The design of the curriculum makes sure that courses build upon each other in terms of knowledge and skills. The programme is student-centred, as it offers ample opportunities for students to follow their personal interests. Moreover, students indicate that they appreciate the design and content of the

programme, which are well aligned with the labour market. Course coordinators frequently discuss the course content in senior staff meetings to ensure alignment between the courses. According to the panel, the curriculum's coherence, focus and alignment with developments in academic research are supported by the fact that the programme is embedded in the Department of Sustainable Development (Copernicus Institute), linked to the Faculty of Geosciences. The panel is very positive about the renewal of the curriculum, which in their opinion will also improve the alignment with the structure of other programmes in the department. The panel appreciates how the programme continually reflects on the content of the curriculum in light of the professional and academic field. This responsive attitude is also reflected in the ongoing incremental changes implemented in the courses. Furthermore, the panel was pleased to learn that students and alumni have been involved in the renewal process. Also, the programme is planning to evaluate the coherency of the new curriculum with students twice next year.

According to the panel, a strong component of the programme is the focus on practice-based skills, particularly in the integration courses. The course descriptions make explicit how each course contributes to academic and professional skills development. The panel learned that one of the reasons to renew the programme is to increase the focus on technical skills such as programming. The panel appreciates this, as these are relevant skills to prepare students for the professional field. A course on data analysis will be compulsory. Also, across the board, skills development will be made more visible in the curriculum. The panel recommends that the programme considers developing learning lines for skills as a 'finishing touch', to strengthen and highlight the already existing attention to skills in all courses. Adding learning lines could contribute to the coherence of skills development in relation to the ILOs, and make this more explicit for students.

The master's thesis is an individual research project of 30 EC (or possibly 45 EC for students from the Systems Analysis track), which will be 45 EC by default in the new curriculum, allowing for more breadth and depth. The thesis project includes a research proposal, the written thesis and an oral presentation. In addition, the supervisor evaluates the overall thesis process. Thesis topics are offered on Blackboard; topics vary from natural science oriented to more energy policy oriented, but the theses are all related to a topical energy-related societal problem. The master's thesis coordinator links students with supervising staff to ensure alignment between the students' research interest and the expertise of the supervisor. Motivated students are encouraged to (re-)write their thesis in the form of a scientific paper; the panel noted that 42 articles based on a master's thesis have been published in peer-reviewed international journals over the past 5 years. During the interviews, the panel learned that the internship will not be part of the new curriculum, although some students would have preferred to keep the option of doing a smaller 30 EC thesis, to be able to combine this with more electives, including an internship. However, the programme will offer the possibility to do the 45 EC thesis partly in a company, since experience shows that these places are easier to find than for internships consisting of less EC. The panel sees this as an ideal way to integrate an internship with research.

In the student chapter, it was mentioned that sometimes the coherency between courses is lacking or there is overlap in content – although students the panel spoke with saw the benefit of this overlap, as some students have no prior knowledge. The panel noted that this complaint has the attention of the programme. For the general elective courses, students can either select from a list of pre-approved electives or select other courses and ask for approval, for which there are guidelines. The panel noted that students would welcome more in-depth electives that are relevant to the programme. In addition, they sometimes struggle to take electives at other (technical) universities because of scheduling issues. To accommodate students, in the new curriculum, all electives in the department will be offered in the same periods, 1 and 2. The Energy and Resources group has also developed two new electives. Although there will be less room for electives in

total due to the 45 EC thesis, the programme tries to be flexible and students also have the option to combine their thesis in period 3 with an elective elsewhere. The panel suggests making it easier for students to take electives elsewhere by providing adequate guidance and information.

Learning environment

Following Utrecht University's educational concept of continuous learning and assessment, the programme strives to offer students a personal, small-group and interaction-intensive learning environment. The courses combine lectures with guest lectures, blended-learning elements, tutorials, computer practicals, assignments, group discussions and projects. Throughout the courses, students work individually, in pairs and in small groups to train working both independently and within a team. The panel values the student centredness of the programme, with the focus on small-group teaching and adequate supervision, feedback and support. The panel is of the opinion that the programme offers varied teaching methods including guest lectures to introduce students to different perspectives, an adequate balance of individual and group activities, and ample opportunity for peer learning. Moreover, the programme provides flexibility and freedom of choice for students in determining their study route and developing their own profile, which is appreciated by the students. The panel is positive about the learning environment, providing good facilities and space for the development of an academic community. In addition, the panel recognizes the high level of student involvement, reinforced by the active study association NRG.

Feasibility

As the panel noted that the duration of the thesis project is not always nominal and that the length of theses varies greatly, from around 30 pages to more than 100 pages, it discussed these aspects with the programme representatives. Delays can occur when, for instance, a company asks for additional data. To ensure that students graduate on time, the programme has implemented strict rules about the duration of the master's thesis trajectory and monitors the progress of theses accordingly. The panel learned that currently, students need to register their starting date. They are given 4 weeks to write their research proposal and 21 weeks (30 EC) or 31,5 weeks (45 EC) to write their thesis. Extensions are granted only in specific circumstances. The panel is positive about these measures. In addition to these, it recommends that a guideline be established for the scope of the thesis, to prevent students from overextending the thesis project unnecessarily, which can only be deviated from with proper justification. The panel also suggests including a guideline for the development of research methods/models, in the interest of both students and lecturers, since a specification of this is missing in the rubric.

The self-evaluation report shows that on average 28% of the students graduate within two years. After two years and three months, this percentage is 44% and after three years this is more than 85%. After studying the curriculum and the interview with students during the site visit, the panel concludes that the programme is feasible within two years. The students find the overall study load well balanced, as was also mentioned in the student chapter.

Guidance

The panel is positive about the guidance and information students receive during the programme and welcomes the provision of programme-specific services and facilities. These include master's information sessions twice a year for prospective students to support their study choice process, and an introductory programme for first-year students. The study association NRG takes an active role as well. The study association organizes a variety of academic- and career-related events as well as social activities, and serves as the link between students, teachers and alumni. The association is also involved in educational quality control. For instance, by participating in the master's Educational Committee and the Energy Science renewal committee.

The panel appreciates that lecturers have a personal approach and are dedicated and responsive towards students. To improve the availability of lecturers, the programme recently started working with two coordinators per course instead of one. The panel noted that student satisfaction about the role of and contact with the track coordinators varies, but does not consider this as a structural problem since starting next academic year, only a single curriculum will be offered, with no separate tracks. Besides the supervision and guidance from the lecturers in the courses, extra support and guidance is available for students. Study advisers are the students' first points of contact when they have individual questions and concerns. If necessary, they can refer students to the specialist services of the university. In the interview, students indicated that they appreciate the guidance offered by study advisers and find them easily accessible. The e-learning platform Blackboard is an important source of information for students. Here, general information is provided regarding entrance requirements for courses, results of course evaluations, news and updates, etc.

Teaching staff

The programme is taught by lecturers from the Copernicus Institute of Sustainable Development who combine teaching and research. The panel is impressed with the quality of the lecturers, who are all experts in their fields, thus providing a clear link between research and teaching and ensuring that state-of-the-art knowledge is taught in the programme. According to the panel, the institute with its societal impact orientation provides an excellent research base and practical input for teaching in the master's programme. Students also highly appreciate the quality and up-to-date knowledge of the teaching staff. Courses are coordinated by a tenured staff member. Additional staff members (junior lecturers and junior assistant professors, 13% of the teaching staff) are sometimes involved in teaching, as well as postdocs and PhD students. The panel notes that teaching quality is ensured through an academic development policy that focuses on both teaching and research qualifications. The department expects temporary teaching staff to take part in the university-wide 'Start to teach' programme. All tenured staff (67%) are required to hold or obtain the University Teaching Qualification (UTQ). The panel observed that the previous accreditation's panel recommendation to consider expanding the teaching staff with lecturers from a background in other disciplines than technology and natural science has been followed up by the Energy & Resources section, by appointing 6 new staff members with a wide variety in scientific backgrounds, including social sciences.

In the interviews, the panel has seen a very experienced and engaged team that covers the academic scope of the programme. Moreover, the lecturers have strong connections with the professional and societal field through their own research activities. The panel is positive about the calibration among staff members; between lecturers regular meetings take place to ensure the alignment and coherence in the curriculum and to discuss teaching practices. The workload of teaching staff was commented on by students, who feel that thesis supervisors are not always available when called upon. Regarding the high workload of teachers, the panel learned that the programme's management has taken several measures to improve this persistent problem, for example by hiring new staff and increasing the supervision hours per student. According to staff, these measures have helped reduce the workload. The panel sees this as a positive development, but recommends continued attention to and evaluation of teacher workload.

Internationalization

The programme has an inherently international orientation, as the energy science field has a global character and increasingly international labour market. The panel supports the choice and underlying argumentation for an English name and language of instruction. According to the panel, this aligns well with the international nature of the professional and academic field. Approximately 25% of the students and 63% of the academic staff are non-Dutch. Through the international focus, students are exposed to different

perspectives and gain experience in collaborating within international teams. The panel also appreciates the availability of exchange programmes for electives, internship and/or thesis at a wide variety of (international) partner universities. The university has adequate professionalization policies in place for ensuring lecturers' proficiency in English.

Considerations

The panel considers the curriculum to be well-structured and coherent. The curriculum covers all ILOs and provides students with a solid, interdisciplinary foundation in Energy Science, with a default track in System Analysis. Starting next academic year, only a single curriculum will be offered, with no separate tracks. However, students will keep ample opportunity to choose their own focus through an individual trajectory. The panel sees the focus on practice-based skills as a strong component of the programme, particularly in the integration courses linked with external organisations. The panel concludes that the development of academic and professional skills is sufficiently addressed in all courses. To further strengthen the coherence of skills development within the curriculum and make this more explicit to students, the panel suggests developing skills learning lines.

The panel appreciates how the curriculum is continually updated in response to developments in the professional and academic field. It is very positive about the recent renewal of the curriculum, which will also improve the alignment with other programmes in the department: to accommodate students, all electives will be offered in the same periods. The panel suggests the programme management could make it easier for students to take electives elsewhere by providing adequate guidance and information. In addition, the panel appreciates that the renewed programme will focus more on technical skills and that it will include a 45 EC master's thesis, with the option to do this in a company as a way to integrate an internship with research.

The panel values the student-centred learning environment, with the focus on small-group, interactive teaching and the high level of student involvement. According to the panel, there is adequate supervision, feedback and support. The courses offer varied teaching methods, including guest lectures to introduce students to different perspectives, projects based on real-life cases, and ample opportunity for peer learning. Moreover, the programme provides flexibility and freedom of choice for students in determining their study route and developing their own profile.

The feasibility of the programme is in order, although delays can occur during the thesis project. The panel noted differences in both duration of the thesis project and length of the theses. It urges the programme to expand the recently introduced rules for the duration of the master's thesis trajectory to include a guideline for the scope of the master's thesis. The panel also suggests including a guideline for the development of research methods/models. Students receive proper information and guidance during the programme, and sufficient extra guidance and support if needed. They appreciate the guidance offered by lecturers and study advisers and find them easily accessible.

The panel is impressed with the quality of the teaching staff. They are all didactically qualified and are experts in their field, covering the academic scope of the programme. The lecturers all combine teaching and research and have strong connections with the professional and societal field through their own research activities. Thus, the Copernicus Institute with its societal impact orientation provides an excellent research base and practical input for the programme. The alignment and cohesion of the curriculum and teaching team are ensured by regular meetings and calibration among staff members. The panel appreciates that the teaching staff has been expanded with 6 new staff members with a wide variety in scientific backgrounds. Thanks in part to the staff increase, the panel sees a positive trend with respect to teachers' perceived high workload, but recommends continued monitoring and evaluation of this workload.

The English-taught programme is internationally oriented, which is reflected in the international community of students and staff. According to the panel, the choice for an English name and language of instruction is well substantiated and in alignment with the international nature of the professional and academic field.

Conclusion

The panel concludes that the programme meets standard 2.

Standard 3. Student assessment

The programme has an adequate system of student assessment in place.

Findings

Assessment system

Assessment in the programme is aligned with the Education and Examination Regulations and Utrecht University's educational model, which includes formative feedback during each course. In a programme-specific assessment plan all assessments and courses are aligned to the ILOs of the programme. This plan includes assessment matrices for each course. It is updated every other year and discussed with the course coordinators. ILOs are tested based on a variety of assessment methods, including written exams, research reports, written assignments and oral presentations or pitches. Intermediate tests and assessments are used to activate students' learning behaviour and to monitor students' progress. Grading of the internship is based on the quality of the practical work, the written final internship report and an oral presentation. The grading is the responsibility of the programmes' supervisor, with the input of the supervisor at the host organization.

The panel considers the assessment system to be well-designed and coherent, with assessment methods that are appropriate for the courses' learning goals and sufficient attention to skills. It appreciates the assessment plan linked with the ILOs, the policy of continuous assessment and the diversity in assessment methods used. The panel observes that appropriate procedures are in place to ensure and enhance the quality of assessment. For example, assessments are reviewed by a colleague before they are administered. Furthermore, the panel notices a strong culture of calibration among teachers, ensuring consistency in grading of assignments, exams and theses. The programme uses standard rubric grading forms, which are checked by programme management. The panel observed that about 80% of the assessments in the programme are individual tests, with the exception of the consultancy project where the entire grade is based on group work. According to the students, there is a good balance between individual and group assignments. During group work, they have regular contact with their supervisor for feedback and can discuss issues, such as the distribution of tasks. The panel is positive about group work monitoring.

The programme representatives indicated that at least two summative assessment moments are used per course, in some cases supplemented with formative assessment. With respect to the workload of teachers, the panel initially had some concerns about continuous assessment and the many different (3 to 7) assessment methods per course, but feels reassured that adequate measures have been taken in this regard to reduce teacher workload. For example, by finding efficient ways to provide feedback to students, and by giving a pass/fail instead of a grade.

The panel also learned that preparatory exams differ per course. Some courses provide material from multiple years, while others do not offer mock exams. The panel sees some room for improvement, in the

sense that it is recommendable to make a deliberate choice about when to include preparatory exams and to provide this information to students in the course guides. According to the panel, overall, students are adequately informed about examinations and assessment criteria.

Thesis assessment

The final product of the programme is the master's thesis of 30 EC or 45 EC, which covers all intended learning outcomes at an individual level. As part of the accreditation process, the panel reviewed a selection of 15 theses from the programme, including the corresponding assessment forms. The rubric for the thesis specifies the assessment criteria based on the ILOs, and serves as a basis for grading. The panel concludes that the rubric is actively used. In the eyes of the panel, the reviewed theses show a good match between the ILOs of the programme, the formulated problem statement and the conclusions. The panel agrees with the grades awarded to the theses and considers the grades to be sufficiently substantiated. In general, the theses are of good quality.

The panel considers the thesis assessment procedure to be well thought out. The thesis project is individually assessed by the supervisor and a second independent assessor, who is not involved in the daily supervision of the student. If necessary, a third assessor is appointed. The evaluations of the theses are checked by the master's thesis coordinator and the Board of Examiners in a stratified random manner. The panel was pleased to learn that the way assessment forms are filled out is discussed regularly during calibration sessions and was the subject of extensive discussion with the Board of Examiners. In response to a request by the Board of Examiners, the assessment form has been modified and now makes explicit that if an item in the rubric has been assessed as 'unacceptable', the student has to repair the thesis. Furthermore, the panel observed that around 15% of the graduates were awarded the distinction cum laude between September 2020 and August 2022. In the interview, programme representatives agreed with the panel that this is a fairly high percentage. The panel is content that they keep an eye on the upward trend in order to prevent 'inflation'.

Board of Examiners

The programme falls under the responsibility of the faculty-wide Board of Examiners. Based on the documentation and the interviews during the site visit, the panel concludes that the Board of Examiners adequately safeguards the quality of assessment in the programme. The Board of Examiners is competent and well aware of current issues and developments, such as artificial intelligence. The Board of Examiners proactively controls the quality of assessment in various ways, such as appointing examiners (holding a UTQ), approving the thesis assessment form, organizing validation meetings in which the grades of theses are discussed, and monitoring cum laude rates. The Committee of Assessments, which advises the Board of Examiners, was involved in an extensive evaluation of the rubrics. This resulted in the recent improvement of assessment forms. The committee also recently completed a proposal for an intervention (peer review) procedure regarding the alignment between courses and course assessments, which will be discussed by the Faculty Board before implementation. The panel is pleased to see that the Board of Examiners clearly contributes to the quality of assessment in the programme and is continuously investigating potential vulnerabilities in the assessment of courses.

Considerations

The panel concludes that the assessment system is transparent and well designed. Adequate procedures, such as the four-eyes principle, are in place to ensure and enhance the quality of assessment. The assessment methods used are diverse and appropriate, and include structural formative feedback. The panel appreciates the attention for the coherency of assessment and the strong culture of calibration among teachers, as well as the efforts to reduce the workload of teachers with regard to continuous assessment,

and to realign the standard rubric forms. The panel is also positive about group work monitoring. There is a good balance between individual and group assignments, with sufficient attention to skills. In addition, the panel advises the programme to establish uniform rules for preparatory exams. To communicate these clearly to students, the panel recommends including more detailed information in the course guides.

The master's thesis covers all ILOs of the programme at an individual level and is always independently assessed by two examiners. The panel considers the thesis assessment procedure to be well thought out. According to the panel, the grades awarded are sufficiently substantiated. There are regular calibration sessions around assessment, with subsequent adjustments as needed, such as the recent modification of the assessment forms.

According to the panel, the Board of Examiners proactively contributes to the quality of assessment in the programme. It safeguards the quality of assessment in the programme in various ways, including the continuous investigation of potential vulnerabilities in the assessment of courses. In particular, the panel appreciates the recent evaluation of the rubrics and the elaborated proposal for a peer review process to encourage alignment between courses and course assessments.

Conclusion

The panel concludes that the programme meets standard 3.

Standard 4. Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings

Theses

The thesis is regarded as the programme's final project in which students demonstrate that they achieved the programme's ILOs at an individual level. In preparation for the site visit, the panel examined a selection of 15 theses. In the selection, a proper distribution across grades was ensured. In the opinion of the panel, the level of the examined theses is appropriate for an academic master's programme. The theses demonstrate the achievement of the ILOs. In general, the theses are of good quality. The panel is impressed by the programme's high cum laude figures.

Alumni

The panel appreciates how students are stimulated through numerous activities to become more acquainted with the future labour market. These include the consultancy project, guest lectures, mutual research projects, internships, the thesis project, and career-related events organized by study association NRG. Career orientation is further supported by Geosciences Career Services and a dedicated career officer. An alumni survey (2021) shows that Energy Science graduates are in high demand; there is an increasing diversity of jobs in the energy science labour market. Most respondents found their first relevant job soon after graduation (55% within three months). After one year, 76% of the graduates found a job in the energy science domain. Graduates find employment as researchers, consultants, policy advisors and practitioners, activists and entrepreneurs in the field of energy science, in public, market-based or civil society organisations. About 10% of the students continued as PhD students at UU or other universities after graduation. The panel is positive about the fact that the majority of alumni found professional positions that match the programme's content and level.

As they indicated during the site visit and in the most recent alumni survey, alumni developed valuable knowledge and skills during the programme, and feel well prepared for the labour market. Because of the applied character of the programme, they learn practical skills such as project management, teamwork and presenting work in public. Modelling skills are also considered useful for the labour market. Based on the documentation and the interviews during the site visit, the panel appreciates that alumni are generally content about the programme and often get relevant positions after graduation.

Considerations

The panel concludes that the level of the theses is appropriate for an academic master's programme. The theses demonstrate the achievement of the ILOs. The documentation and interviews show that alumni are generally content about the programme and are well prepared to perform successfully in the professional field.

Conclusion

The panel concludes that the programme meets standard 4.

Development points

1. Develop skills learning lines to strengthen and highlight the existing attention to skills in all courses, and to contribute to the coherence of skills development, while at the same time making this more explicit for students.
2. Continue to monitor and evaluate the workload of teachers.
3. Establish uniform rules for preparatory exams, and provide more detailed information about this for students in course guides.
4. Establish a guideline for the scope of the master's thesis, and include a guideline for the development of research methods/models.

Appendix 1. Intended learning outcomes

1. The graduate 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. The graduate 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. The graduate has the ability to apply knowledge and research methods, and has 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. The graduate 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. The graduate has professional and academic skills, in particular in relation to the dynamics and challenges of Energy Science;
6. The graduate is able to apply knowledge and understanding in such a way that he or she demonstrates a professional approach to their work;
7. The graduate 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.
8. The graduate is able to study and work independently and explore new areas of interest in the field of the programme or related fields and demonstrate a professional approach to their work.

Appendix 2. Programme curriculum

Systems Analysis track	Year 1			
	Energy in the Context of Sustainability (7.5 EC)	Advanced Energy Analysis (7.5 EC)	Energy Systems Modeling (7.5 EC)	Consultancy Project (15 EC)
	Energy Conversion Technologies 1 (7.5 EC)	Energy Conversion Technologies 2 (7.5 EC)	Elective (7.5 EC)	
Systems Analysis track	Year 2			
	Internship * (15 or 22.5 EC) and /or electives (7.5 or 30 EC)	Internship and/or Electives and/or Master thesis *	Master thesis* (30 or 45 EC)	
Natural Science track	Year 1			
	Energy in the Context of Sustainability (7.5 EC)	Advanced Energy Analysis (7.5 EC)	Energy Systems Modeling (7.5 EC)	Natural Science Research Project** (7.5 of 30 EC)
	Energy Conversion Technologies 1 (7.5 EC)	Energy Conversion Technologies 2 (7.5 EC)	(Natural Science) Elective*** (7.5 EC)	(Natural Science) Elective *** (7.5 EC)
Natural Science track	Year 2			
	Natural Science Research Project** (22.5 of 30 EC)	(Natural Science) Elective*** (7.5 EC)	Master thesis (30 EC)	
		Natural Science Research Project** (7.5 of 30 EC)		
<div><div><div>Interdisciplinary context course</div><div>Science and Technology course</div><div>Energy Systems course</div></div><div><div>Elective course</div><div>Natural Science elective course</div><div>Integration and research course</div></div></div> <p>* in the 2nd year of the systems analysis track students can choose to do an internship (15-22.5 EC), and or electives (7.7 – 22.5 EC) besides a 30-45 EC Masters thesis. The sequence of these courses is flexible.</p> <p>** in the natural sciences track, there is flexibility in the sequence of the natural research project and electives. Master thesis is done after the natural science research project.</p> <p>*** In the natural sciences track, at least 2 out of 3 electives need to be natural science oriented.</p>				

Appendix 3. Programme of the site visit

Tuesday 18 June 2024

13:00		Arrival committee
13:00	13:45	Preparations committee
13:45	14:30	Vice-dean and programme management
14:30	14:45	Break
14:45	15:15	GSS Bachelor students
15:15	15:30	Break
15:30	16:00	Environmental Sciences Master students
16:00	16:30	Energy Science Master students

Wednesday 19 June 2024

09:00		Arrival committee
09:15	09:45	Alumni (online)
09:45	10:00	break
10:00	10:30	GSS Bachelor lecturers and study advisor
10:30	10:45	Break
10:45	11:15	Environmental Sciences Master lecturers and study advisor
11:15	11:30	Break
11:30	12:00	Energy Science Master lecturers and study advisor
12:00	13:15	Lunch break
13:15	14:00	Board of Examiners
14:00	14:30	Break
14:30	15:15	Vice-dean and programme management
15:15	16:45	Deliberations panel
16:45	17:00	Main findings presented by panel chair
17:30	18:15	Development dialogue

Appendix 4. Materials

Prior to the site visit, the panel studied 15 theses master's programme Energy Science. Information on the theses is available from Academion upon request. The panel also studied other materials, which included:

- Self-evaluation report, including the following appendices:
 - Organisation of the programme
 - Follow up actions previous assessments
 - Domain-Specific Framework of Reference
 - Overview of the intended learning outcomes in relation to the Dublin descriptors
 - Key figures – source OSIRIS
 - Overview staff
 - Overview master's thesis topics
 - Members Advisory Board of the Copernicus Institute
 - Course calendars 2022 – 2023
 - Course guide
 - Institutional quality assurance assessment
 - Assessment plan
 - Internal year evaluations and NSE
 - Outflow students to labour market
 - Activities to prepare students for the labour market
 - Thesis based publications
 - Renewal Energy Science master's degree programme
- Staff-student ratio
- Theses and rubrics
- Alumni survey (report 2021)
- Annual report Examining Board 2022-2023
- Quality assurance report Geosciences 2024
- Agenda meetings Societal advisory board Copernicus Institute of Sustainable Development