TILSYNS-RAPPORT

Master in Sustainable Energy Technology

Western Norway University of Applied Sciences
(Høgskulen på Vestlandet)

2022

NOKUT

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Institution	Western Norway University of Applied Sciences
The provisions name	Master in Sustainable Energy Technology
Degree / Study point	Master / 120 ECTS
Expert committee	Peter M. Haugan, Viktoria Martin
Decision date	24.06.2022
NOKUTs case number	21/08413

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Introduction

The external quality assurance performed by NOKUT consists of evaluating the institution's quality assurance systems, accreditation of new provisions and revision of accredited provisions. Universities and university colleges have different self-accrediting powers. For an institution without self-accrediting powers to establish a provision in a certain cycle an application must be made to NOKUT.

Hereby NOKUT presents the accreditation report of Master in Sustainable Energy Technology at Western Norway University of Applied Sciences (Høgskulen på Vestlandet). The expert evaluation in this report is part of the accreditation process following the institution's application for accreditation. This report clearly indicates the extensive evaluation performed to ensure the educational quality of the planned educational provision.

The Master in Sustainable Energy Technology at Western Norway University of Applied Sciences does fulfil the conditions for accreditation in the Regulation concerning NOKUT's supervision and control of the quality in Norwegian higher education.

Kristin Vinje
Chief Executive

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1 Information regarding the applicant institution

Western Norway University of Applied Sciences (Høgskulen på Vestlandet) is a merger of three university colleges; Bergen University College (Høgskolen i Bergen), Sogn and Fjordane University College (Høgskulen i Sogn og Fjordane) and Stord/Haugesund University College (Høgskolen i Stord/Haugesund). The merger took place 1. January 2017. The Board of Western Norway University College of Applied Sciences revised and adopted the institution's quality assurance system 13. November 2018.

As a University College, Western Norway University of Applied Sciences (HVL) has self-accreditation rights for all bachelor level programmes. HVL must apply NOKUT for accreditation of programmes at master's and PhD level. HVL applied for accreditation of Master in Sustainable Energy Technology by the application deadline of 15. September 2021.

2 Decision

NOKUT made the following decision on 24th June 2022:

NOKUT considers that the criteria in the regulations are fulfilled. We therefore accredit the Master in Sustainable Energy Technology at Western Norway University of Applied Sciences. The accreditation is valid from this date.

The original decision in Norwegian:

NOKUT vurderer at vilkårene i NOKUTs forskrift om tilsyn med utdanningskvaliteten i høyere utdanning av 9. februar 2017 og i forskrift om kvalitetssikring og kvalitetsutvikling i høyere utdanning og fagskoleutdanning av 1. februar 2010 nå er oppfylt.

Vi akkrediterer derfor utdanningen Master i bærekraftig energiteknologi (120 studiepoeng) ved Høgskulen på Vestlandet.

3 Expert assessment

This chapter is the expert committee's assessment. The term "we" refers to the expert committee as such.

3.1 Summary

HVL has applied for a 2 year's MSc programme in Sustainable Energy Technology. With a well-known name of the programme, their proposal is nevertheless unique as it profiles marine energy systems and sustainable shipping. Hence, it caters well to the location of the university, its established network of partners in research, excellent established lab infrastructure and the competence of the core faculty presented.

The programme is well presented in the programme's syllabus, and shows a relevant and well-elaborated structure, mixing mandatory courses to form the base with a multitude of electives to allow the student to choose their specialisation. The MSc thesis-project can be either 30 ECTS, or 50 ECTS with the latter option being especially suitable for more research oriented (and potentially PhD preparatory) work.

Overall, it is the view of the expert committee that this programme is highly relevant, well-structured and has the opportunity to attract talent and then serve the many stakeholders involved in the transition to sustainable development with much needed engineering expertise. Nevertheless, there are a few aspects of the programme that must be improved before approval: It is necessary that the possibilities for students to be linked to internal and external research projects during their studies is further elaborated. In addition to this requirement, a multitude of suggestions are provided in this evaluation, which we feel will contribute to the final shaping of the programme design and to successful running of the programme. Also the committee finds it necessary that a course, or course content, related to engineering economics or techno-economic models for assessing energy investment and operations, is added to the mandatory programme-curriculum.

Summary in consideration of the institution's response

The requirement for a new mandatory course or course content has been fulfilled by adding a course on energy economics, which is well placed in the overall curriculum. In addition, the requirement on clearly elaborating the students' opportunities to get connected to research is now met, as examplified in different opportunities in specific courses, and master's thesis projects.

3.2 Basic prerequisites for accreditation

3.2.1 Demands expressed in the Universities and College Act

Regulations on Quality Assurance in Higher Education
Section 3-1 (4) It is a condition for accreditation being granted that the requirements of the Universities and University Colleges Act are met. Regulations adopted under the authority of Section 3-2 of the Universities and University Colleges Act shall form the basis for the accreditation.

Academic Supervision Regulations
Section 2-1 (1) The requirements of the Act relating to Universities and University Colleges and its corresponding regulations must be met.

Assessment

Requirements for management scheme, regulations, appeals board, learning environment committee and quality assurance system are not considered in this assessment, as the institution is an accredited university college. In this assessment, only requirements in the Regulations that are relevant for a master's degree are assessed, including requirements for admission, diplomas and diploma supplement.

Requirement for admission

The admission requirement to the master's program is a relevant 3-year degree (bachelor's degree) in engineering, based on the National Curriculum Regulation for Engineering Education (*forskrift om rammeplan for ingeniørutdanning*), or equivalent, with average grade of at least C. Following requirements are set for certain subjects, in addition to the minimum requirements in the National Curriculum Regulation:

- At least 25 ECTS in mathematics
- At least 5 ECTS in statistics
- At least 7.5 ECTS in physics, of which 5 ECTS in thermodynamics / technical thermodynamics (*termodynamikk / teknisk varmelære*)
- At least 5 ECTS in fluid mechanics / fluid theory (*fluidmekanikk / strømningslære*)

The requirements that students have passed courses in thermodynamics and fluid mechanics at bachelor level is to ensure the academic prerequisite for the master's program.

These requirements for admission to the master study are assessed to be adequate and in line with the Regulations.

Diploma and Diploma Supplement

Both, the Diploma and Diploma Supplement provide adequate and correct information.

Conclusion

Yes, the requirements are fulfilled.

3.2.2 Information about the programme

Academic Supervision Regulations
Section 2-1 (2) Information provided about the programme must be correct and show the programme's content, structure and progression, as well as opportunities for student exchanges.

Assessment

Information about the programme is thoroughly, and correctly put together in the programme syllabus (appendix 4 to the application), that contains the required information about content, structure, internationalisation and student exchange. It serves as a good basis for also presenting thorough information on the programme's website.

Since this evaluation comes with a requirement for updating in Section 3.3.6, it is strongly recommended that the programme information is updated accordingly. (You are asked to elaborate the possibilities for students to be linked to internal and external research projects during their studies including the possibilities for co-supervision of master theses.)

Conclusion

Yes, the requirements are fulfilled.

Reassessment in consideration of the institution's response

In the original assessment, HVL was adviced (though not requested) to update the programme description according to changes made based on this evaluation of the application. The programme description HVL sent in the appendix to their response, reflects all the changes that have been made to the programme (see 3.3.6). HVL would benefit from promoting information about the various possibilities for students to be linked to internal and external research projects during their studies also in the external information about the programme.

The institution is advised to:

- clearly promote externally the various opportunities for programme participants to get in touch with unique and state-of-the-art research.

3.3 Demands to the educational provision

3.3.1 Learning outcome and title of programme

Academic Supervision Regulations
Section 2-2 (1) The learning outcomes for the programme must be in accordance with the National Qualifications Framework for Lifelong Learning, and the programme must have an appropriate title.

Assessment

The title of the programme is well-known, and relevant, although the unique connection of this programme with regards to marine energy systems could be highlighted already in the title. In the long run, this could potentially attract students from a wider area (including Europe and the rest of the world), especially if a good connection and collaboration with relevant industrial partners is realized within the programme (MSc thesis, etc).

The learning outcomes are very relevant, although especially those that are related to "Knowledge" are not formulated as student centered, with "active" verbs and addressing taxonomy of learning. It is realized that this is most likely due to following the national qualification framework, but still it is advisable to think specifically of student centered and active learning. Possibly the learning outcomes per course could be sharpened in time.

The learning outcomes could more explicitly express economic models and tools for e.g. techno-economic analysis, and assessing energy investment and operations.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- include energy economics and techno-economic theories models and tools into the learning outcomes.

3.3.2 The programme's academic update and professional relevance

Academic Supervision Regulations Section 2-2 (2) The programme must be academically up-to-date and have clear academic relevance for further studies and/or employment.

Assessment

The programme aims to service the need for engineering competency related to the transition of energy systems based on renewable energy sources, and for sustainable development. This need is well-outlined internationally (e.g. EU SET Plan on education and training[1]) and nationally as high-lighted by the HVL self-evaluation. The content is academically up-to date and especially organized to target a relatively unique educational segment of marine energy systems and sustainable shipping. The application comes with letters of support from Bergen Næringsråd, NCE Maritime Cleantech and Arena Ocean Hyway Cluster. In combination, it describes how the topical area outlined by this programme application brings great opportunities for Western Norway especially, and Norway as a whole, to capture societal values (business and industrial opportunities, job

[1] EU, 2014 «Strategic Energy Technology (SET) plan European energy education and training initiative» https://op.europa.eu/en/publication-detail/-/publication/2883a63f-e87e-464b-8cec-eccd6bbb0330/language-en

creation, etc) while making good impact on sustainable development. However, these stakeholders highlight the importance of having properly trained professionals, engineers, available to cater to the rapid transformations and developments. After completing the outlined programme, graduates should thus have good opportunities for employment.

As the master's level curriculum is clearly planned to closely follow research, and engage with research and development activities, graduates of this programme are likely to be able to pursue also a research career, with continued PhD level studies, should they desire to do so. Here, they can for example opt for a study-plan with a 50 credits master's thesis topic, instead of the common 30 credits, and thereby be able to investigate certain research questions in-depth already in their master education. The need for research and development relevant to this topical area is immense and urgent, and many opportunities for further studies exist.

The institution should ensure the engagement of relevant stakeholders, like industrial partners, in the programme, and ensure a close connection to research and development activities linked to HVL, as well as to external research institutes, within the programme's learning activities.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- ensure the engagement of relevant stakeholders, like industrial partners, in the programme.
- ensure a close connection to research and development activities linked to HVL, as well as to external research institutes, within the programme's learning activities.

3.3.3 The programme's workload

Academic Supervision Regulations
Section 2-2 (3) The total workload of the programme must be between 1,500 and 1,800 hours per year for full-time students.

Assessment

HVL estimates the students' workload per semester with a total of approx. 810 hours per semester, that is 1620 hours per year. Appendix 6 in the applications shows in detail how many hours per subject are reserved for different learning activities, such as tuition, studies and exam preparation. The distribution of hours per learning activity varies, depending on the different factors that are specific to each subject. Overall, the committee finds the estimated workload realistic. The time-distribution concerning the learning activities for each subject seems reasonable and will contribute to the students reaching the intended learning goals.

Conclusion

Yes, the requirements are fulfilled.

3.3.4 The programme's content, structure and infrastructure

Academic Supervision Regulations
Section 2-2 (4) The programme's content, structure and infrastructure must be adapted to the programme's learning outcomes.

Assessment

The content is well distributed and balanced, with a mandatory set of courses introducing important topics to serve as a broad base for the Sustainable Energy Technology, and in addition a good amount of study credits being available for students choosing their profile courses for more in-depth studies. Hence, the knowledge base caters well to the described intended learning outcomes (Knowledge) of the programme. However, as described in section 3.3.1 there is no explicit content apparent for addressing economic models and tools for e.g. techno-economic analysis, and assessing energy investment and operations. It is required that such a course, or course content, is either added (along with adding ILO on the matter), or more clearly brought forward through the proposed courses' content.

Overall, the programme's content and structure is clearly presented, and connected to the learning outcomes. For example, there are ample opportunities for students to apply methods and develop their skills in a challenge-driven setting, especially via the 10 credits preparatory project (MAS550) and the master's thesis. Similarly, many of the courses have content related to general competences, like group work, communication, and analysing environmental and social implications of products and system solutions of relevance to the subject area. Here again, it is less described how analyses of economic implications is trained within the curriculum.

The connections, and progression of learning activities and learning outcomes, related to all dimensions of sustainable development are not clearly presented or evidenced by the course package. The committee acknowledges, that this aspect is visible through learning outcome GK1. However, it is advisable to provide an explanation of how the dimensions of environmental/societal/economical sustainability will be put forward in learning activities throughout the programme (not only through the courses MAS503 and MAS520, but also how the lessons learned from these are picked up in the rest of the curriculum).

With regards to infrastructure, the programme will be hosted in modern facilities at the Bergen Campus. These facilities allow for opportunities in student-faculty interactions. A valuable set of lab facilities will be made available for the learning activities in the programme, and these labs are also staffed with engineers to facilitate their use. Examples are the marine lab with tank facility to explore marine constructions and ocean-based energy harvesting, and the biofuels lab encompassing generation of biodiesel and gas, as well as test labs for engine types to go with the new fuels. There are also interesting possibilities for access to additional infrastructure in the region, such as the Norwegian Sustainable Energy Catapult Centre.

Reassessment in consideration of the institution's response

The course MAS504 has been added to the curriculum and it addresses the expert committee's requirement, to add a course, or course content, to the mandatory programme curriculum related to engineering economics or techno-economic models for assessing energy investment and operations. The added course is well described and well placed within the curriculum regarding the programme's content and structure. A minor comment is that the literature for the course is about 20 years old or more. With the increased focus on circularity and sustainability during the past two decades, it is expected although not explicitly stated that some newer developments and examples of application will also be reflected in the teaching. The institution is adviced to update the literature for the subject in the future. In conclusion, the requirement has been fulfilled.

Conclusion
Yes, the requirements are fulfilled.

The institution is advised to:

- update the literature related to the course MAS504 in the future, to better reflect new developments e.g. related to circular economy.

3.3.5 Teaching, learning and assessment methods

Academic Supervision Regulations
Section 2-2 (5) The teaching, learning and assessment methods must be adapted to the programme's learning outcomes. The programme must facilitate students taking an active role in the learning process.

Assessment

The learning methods appear traditional and varied, with lectures and exercises highlighted, as well as lab exercises (e.g. Biodrivstoff og elektrofuels MAS531), project work, and self studies. Focus is on traditional lectures to carry the presentation of key concepts, supporting the knowledge-related learning outcomes, but also to let students get to know the faculty and teachers. Projects, case studies and problem-based learning (e.g. MAS520 Design for Sustainable Energy Technology) is organized to support the development of skills and general competencies.

The programme-plan is taking into consideration a number of lab environments (SolarLab, MarinLab, etc) to support the learning. Their integration in the course work ensures that theoretical studies can be mixed with practical elements for learning.

Integration of digital environments (via LMS Canvas, digital lectures – live and recorded, interactive presentation software, etc), that everyone has gotten well familiar with due to the pandemic restrictions, will continue to be an important part of the programme's learning environment, and said to promote student engagement in the learning activities.

Also the assessment methods stated are varied: written and oral exams, assignments, group activities and take-home exams. Via the project work, peer-assessment is incoporated, as is both written and oral presentation of the project results. Especially interesting is the case of portfolio evaluation, to evaluate the progression throughout the students' studies.

Active engagement will be encouraged throughout, using the above, and further supported by frequent feedback and guidance from the faculty of education.

We find that there is a good variety of teaching, learning and assessment methods. The institution should ensure that this variety is being preserved in the future.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- continue to work and preserve the variety in teaching and learning and assessment methods in the future.

3.3.6 Links to research and/or artistic development work and academic development work

Academic Supervision Regulations
Section 2-2 (6) The programme must have relevant links to research and academic development work and/or artistic research.

Assessment

The staff has well demonstrated ability to perform research and technical development in topics related to the master (and beyond). The Marine Lab and other facilities at HVL as well as those available through the Sustainable Energy infrastructure offer opportunities for linking students to research and development projects involving both HVL staff and personnel from industry.

Links to research at HVL are not well spelled out, but could e.g. be achieved through courses with mandatory tasks and/or by explicitly linking master's theses to research projects. Links to research and development activities outside the HVL are also not well spelled out, but could e.g. be achieved through involving individuals from industry or other academic institutions (through Bergen Energy Lab or beyond) in co-supervising master's theses. Such or other efforts may be intended. The stated interests from regional businesses and organizations in the master's programme and the high level of relevant activities in the region suggests that there is a great potential. However, a more thorough explanation of active involvement of students in research projects, and involvement of external co-supervisors is required. Explaining such linkages in outreach material including the programme's website could also serve to attract more well-qualified students and clarify the distinct qualities of this programme, such as the marine and maritime profile.

Reassessment in consideration of the institution's response

In it's response, HVL has elaborated well how the students of the proposed programme will be linked to research activities, e.g. through the specialty courses in Marine Engineering, Solar Energy, Bio- and Electrofuels (guest lectures, seminars, and more) and in the work with the master's thesis. A list of examples for thesis projects with research connection from the past is appended. Examples of projects provided by the industry are given, e.g. one on Stirling Engines with Energi AS. Since the application for this study program has been sent, HVL has also been granted additional funding for research, which even further strengthens the opportunities for students to get in touch with state-of-the-Art research and development. The conclusion is that the requirement has been fulfilled.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- clearly promote externally the various opportunities for programme participants to get in touch with unique and state-of-the-art research.

3.3.7 The programme's internationalisation arrangements

Academic Supervision Regulations
Section 2-2 (7) The programme must have internationalisation arrangements adapted to the programme's level, scope and other characteristics.

Assessment

The ongoing energy transition and focus on sustainability in all its dimensions is a global phenomenon with strong presence in particular in Europe, as expressed in policies and regulations. Norway is in a very special situation with respect to this, with an electricity supply both to industries and domestic use being dominated by hydropower, but with a very high per capita energy use and wealth, with oil and gas as the dominating export industry and largest source of public income, and Norway being strongly linked to (though not a member) of the European Union. Having also the largest offshore wind resources of any European country and a strong presence in international shipping and seafood production, makes Norway a capable actor and technology provider in marine and maritime aspects of sustainable energy transition.

The HVL Sustainable Energy Technology Master is structured to address these opportunities. It responds to emerging needs from marine and maritime industry clusters centered in Western Norway and interests from new cohorts of students wanting to be part of this transition. Internationalisation arrangements should be seen in the context of the wider change occurring in other countries, but be tailored to the expectations of the local and regional context.

In general sustainable energy and marine and maritime technology are very international fields of work. International PhD-students contribute to the academic and student environment. E.g there is active collaboration with Jaffna University (Sri Lanka) and Coimbature Institute of Technology (India). Excursions to relevant destinations and participation in international conferences will contribute, too, as will the students' exposure to companies and other international actors in the region.

Exchange of teachers will be a specific contribution to internationalisation. The programme has arrangements with Strathclyde and the Polytechnic University of Valencia. In particular, the link with Strathclyde is very relevant for the maritime and marine technology focus of the present master. Their strong profile in renewable energy and energy transition, including offshore wind but also education of naval architects, will be useful for HVL.

In total, all the mentioned above will be beneficial for all students including those students who do not take part in active student exchange abroad.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- continue to keep being informed about related developments in Europe, in order to both pick up new developments in a rapidly evolving field, and be considered as possible partner in new collaborative arrangements.
- Make sure students are informed about the various international arrangements contributing to the programme.

3.3.8 The programme's arrangements for international student exchange

Academic Supervision Regulations
Section 2-2 (8) Programmes that lead to a degree must have arrangements for international student exchanges. The content of the exchange programme must be academically relevant.

Assessment

The programme has arrangements with Strathclyde and the Polytechnic University of Valencia. Especially the link with Strathclyde is very relevant for the maritime and marine technology focus of the present master. Their strong profile in renewable energy and energy transition, including offshore wind but also education of naval architects, will be useful for HVL. The stated capacity for student exchange appears adequate. The arrangements with Valencia are broader but also useful and with adequate capacity.

Exchanges for HVL students will take place in parts of the second year of study or during the entire second year. This timing secures a common basis at HVL from the first year, work with the thesis abroad and optionally specialization courses taken at Strathclyde or in Valencia. This arrangement seems well justified and will allow the outgoing students to benefit not only from working in another environment, but also have access to a wider set of expertise and project activities.

Conclusion

Yes, the requirements are fulfilled.

3.3.9 Supervised professional training

Academic Supervision Regulations Section 2-2 (9) Programmes that include supervised professional training must have formal agreements between the institution and the host for the supervised professional training.

Not applicable for this programme.

3.3.10 The programme's defined limitations and academic breadth

Regulations on Quality Assurance in Higher Education Section 3-2 (1) Master's degree programmes shall be defined, delimited and have sufficient academic breadth.

Assessment

Sustainable energy technology is a very broad field with many specialisations. It would be difficult for any institution, even the larger global technology institutions, to cover all aspects. However, there are some basic components that should be included in all programmes in this field and some skill sets that every student with a master in sustainable energy technology should possess. Graduates would also be expected to be trained in working in depth in some specialised direction in order to achieve problem solving experience. Since an engineering bachelor is a prerequisite for the present programme, the starting point for all students is homogeneous and well known. This allows the core engineering subjects of the master programme to be taught in an efficient manner. The related courses do cover the essentials as expected. The chosen specialisations are highly relevant both to the regional businesses and the global energy transition.

Given the ongoing and expected key role of electrification in sustainable energy transition, it is a little surprising that electric power and electric systems seem to receive limited attention in the programme. Since HVL does have both, a bachelor's programme in electric power and involvement in master's level education in this field, there should be good opportunities for collaboration and offering e.g. master's thesis topics in electric systems. While there may be reasons for this programme to emphasize sustainable fuels in the courses at the moment, hybrid electric systems could be considered in master's thesis work from the start and perhaps later also further developed with more advanced courses.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- consider integration with electric systems in master projects.

3.4 Academic environment

3.4.1 The academic environment's composition, size and competence

Academic Supervision Regulations
Section 2-3 (1) The academic environment for each programme must be of a size proportionate to the number of students and the programme's characteristics, be stable over time in terms of competence and have a composition that covers the programme's topics and subjects.

Regulations on Quality Assurance in Higher Education
Section 3-2 (2) Master's degree programmes shall have a broad, stable academic environment comprising a sufficient number of staff with high academic expertise in education, research or artistic research and academic development work within the field of study. The academic environment shall cover the subjects and courses that the study programme comprises. Staff members in the academic environment in question must have relevant expertise.

Assessment

The academic environment is centred on the engineering competence in the Bergen campus. This environment appears robust in the core engineering disciplines and has a track record within energy related education and research. The research experience and competence is unquestionably at a sufficient level, with senior members of the team clearly having demonstrated such capabilities and all team members having relevant expertise.

There are a total of 3 academic person-years involved in teaching and supervision of this programme (and a total of 7.9 if also research-activities are taken into account), which means there will be approximately 13 students per academic employee. Together with members of the research groups associated with the planned master's programme, there will be about 20 academic individuals involved in tutoring and supervision of the students' master's theses. In order to cover the breadth of topics required for sustainable energy considerations, the Bergen centred team has been broadened with other skill sets, with parts of the team residing away from the Bergen campus. The efficient integration of all the involved in a coherent sustainable energy team may require some attention, as will the actual delivery of lectures and student supervision whether remotely or through physical presence.

The academic environment does cover the required expertise for the listed courses and subjects. It is important to make sure that future staff changes will not have negative impact on the master's programme. This may be particularly relevant for topics which are not core engineering subjects. In particular, there is one course covering broader aspects of sustainability. The content and quality of this course will be important in order to make sure that the many different and difficult aspects of sustainability are internalised by the students, sustainability becoming more than icing on the cake. The course as described

seems to have these qualities, but there should be continuous attention to this topic in order to make sure that the quality is maintained.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- pay attention to potential vulnerabilities in connection with future staff changes.

3.4.2 The academic environment's educational competence

Academic Supervision Regulations
Section 2-3 (2) The academic environment must have relevant educational competence.

Assessment

The key staff members are highly experienced in education and also have related formal competence. HVL has been fairly recently established as a multicampus applied science university and appears to have put considerable attention to development of educational tools, including e-learning techniques. HVL provides several opportunities to further develop the educational competence of their academic staff, by training offers such as Medialab, Læringslab and in collaboration with Avdeling for læring og utdanning.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- continue to pay attention to integrating different learning methods as they develop.

3.4.3 Academic leadership

Academic Supervision Regulations
Section 2-3 (3) The programme must have a clear academic leadership with defined responsibilities for quality assurance and the development of the study programme.

Assessment

The programme will have a responsible study programme manager (studieprogramansvarlig, SPA) as well as a deputy SPA. Both of these individuals have been identified in the application and do appear to have the formal competence expected for such positions. The described plan for quality assurance of courses and systems at HVL is convincing.

The present master's programme together with the 6 bachelor's programmes of the host department will be represented in a common Study Programme Board (studieprogramråd). This board will in addition to the new SPA also be expanded with a student from the new master's programme for a total of 4 students. This fairly large board may be a suitable unit

for many aspects of quality assurance, including the facilitation of coherence between bachelor's level and master's level education. However, it may be too broad for indepth discussion of aspects specific to the master's programme. It seems that there could be scope for an additional and probably smaller group including both first and second year students from the master's programme as well as external representation to discuss strategy and quality assurance of master's level specifics, including supervision. Such a group could also give advice on the external marketing of the master's programme to students at and beyond HVL, as well as maintenance of the strong links to industry and other regional partners.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- consider additional mechanisms to ensure quality assurance of all aspects specific to the master's programme, including supervision.

3.4.4 Staff with primary employment

Academic Supervision Regulations
Section
2-3 (4) At least 50 per cent of the academic full-time equivalents affiliated to the programme must be staff with their primary employment at the institution. Of these, academic staff with at least associate professor qualifications must be represented among those who teach the core elements of the programme. In addition, the following requirements apply to the academic environment's level of competence:

a) For first-cycle programmes, at least 20 per cent of the members of the academic environment must have at least associate professor qualifications.

b) For second-cycle programmes, at least 50 per cent of the members of the academic environment must have at least associate professor qualifications. Within this 50 per cent, at least 10 per cent must have professor or docent qualifications.

c) For third-cycle programmes, the academic environment must consist of academic staff with at least associate professor qualifications. At least 50 per cent must have professor qualifications.

Assessment

In total, the academic environment of the programme consist of 14 individuals (7.9 person-years) and all but one hold a permanent full-time position at HVL. All of the academic staff have at least associate professor qualifications, 5 of them (2.5 person-years = about 31,6 % of the total academic environment) having professor qualifications. The quantitative requirements are thereby fulfilled.

The programme application describes a set of core faculty, consisting of 12 persons of which 4 are professors, and 8 have associate professor competency. In combination, the faculty also represent topical core elements of the programme's content, related to (but not limited to): sustainable development, industrial systems, hydrogen, materials for clean energy, and life cycle assessment.

Hence, the requirement is fulfilled, although the gender balance in this group is very troubling. Setting out to work with sustainability, a balanced representation is desirable.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- work longterm with securing talent by devloping a gender balanced faculty.

3.4.5 The academic environment's research and/or artistic research and academic development work

Academic Supervision Regulations
Section 2-3 (5) The academic environment must be actively engaged in research and academic development work and/or artistic research, and be able to demonstrate documented results with a satisfactory quality and scope in relation to the programme's content and level.

Regulations on Quality Assurance in Higher Education
Section 3-2 (3) The academic environment must be able to demonstrate documented results at a high level, and results from collaborations with other academic environments, nationally and internationally. The institution's assessments shall be documented so that NOKUT can use them in its work.

Assessment

In the core faculty, well-published researchers are involved, for example:

- One professor has an h-index of 24 (scopus), well-published in the area of nano materials for energy applications.
- Another professor has an h-index 16 (scopus), published in the area of a variety of solar technologies and applications.
- One associate professor has an h-index 2 (scopus), published on off-shore wind and wave energy systems.

Upon reviewing all the appended CVs, in addition to the above, there are researchers primarily focusing on combustion (flames, engines), materials (strength of, and other properties) and sustainable development and LCA. While there is published work, the production (engagement in scientific research) is not huge. Strong research output in the core area of the proposed programme (energy systems and maritime technologies) is lacking.

Despite the publication record described above, what is of great importance here is the high involvement in national and international projects of high relevance to the core area of the programme. To mention a few, there is HYDROMORE (NFR) with focus on future mooring systems for floating ocean-based renewable energy systems; and DecomTools (Interreg, EU) on end of lifecycle approaches for offshore wind farms. This engagement is important, and can to some extent compensate for the present lack of published work. Also, it is very promising for impactful publications coming in the future.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- stay engaged in research and development, involving industrial and international partners.
- be steadfast in building the research output and making it impactful.

3.4.6 The academic environment's external participation

Academic Supervision Regulations Section 2-3 (6) The academic environment for programmes that lead to a degree must actively participate in national and international partnerships and networks that are relevant for the programme.

Assessment

The programme aims to support Norway's ambitions of having renewable energy carriers and technologies becoming an important line of export trade. Hence, the global context and global sustainable development is central to the programme. The academic staff engaged has diverse backgrounds, coming from a multitude of countries, and conduct their research in an international setting with conferences, workshops etc.

Participating institutions in the programme are well linked to several national and international networks. Examples are the national networks Arena Pro Ocean Hyway Cluster which arranges the International Conference on Maritime Hydrogen and Marine Energy, and the Norwegian Hydrogen Associations. Solid partnerships with international universities exist, with UPV and University of Strathclyde being the two fronted as most beneficial for this programme.

This brief summary shows that the academic environment is active in national and international partnerships of good value to the proposed programme.

Conclusion

Yes, the requirements are fulfilled.

The institution is advised to:

- continue to nurture relevant network activities, to support impactful research development, and enable good opportunities for master's thesis projects and for the graduates of the programme.

3.4.7 Supervision of professional training

Academic Supervision Regulations Section 2-3 (7) For programmes involving mandatory supervised professional training, the members of the academic environment must have relevant and updated knowledge from the field of the professional training. The institution must ensure that professional training supervisors have relevant competence and experience in the field of the professional training.

Not applicable for this programme.

4 Conclusion

Based on the written application and the attached documentation, the expert committee concludes the following:

The committee recommends accreditation of the Master in Sustainable Energy Technology (Master i bærekraftig energiteknologi) at Western Norway University of Applied Sciences (Høgskulen på Vestlandet).

In this report the committee has provided advice for the further development of this educational provision. Please see the individual assessments and conclusions above.

5 Documentation

21/08413-1	HØGSKULEN PÅ VESTLANDET - søknad om akkreditering av master i Master i bærekraftig energiteknologi
21/08413-2	HØGSKULEN PÅ VESTLANDET – Institusjonsprofil
21/08413-16	Svar på utkast til rapport – akkreditering av master i bærekraftig energiteknologi ved Høgskulen på Vestlandet

Appendix

Learning outcome of the programme

After completing the study programme, the candidate has achieved the following Learning Outcomes, defined under Knowledge, Skills, and Responsibility and Autonomy:

Knowledge
The candidate ...
• has advanced knowledge of structures, materials for the design of energy systems.
• has detailed knowledge of sources of energy, technology for harvesting and converting energy, and various energy carriers with focus on energy efficiency and sustainable use of energy.
• has in-depth knowledge within a selection of the study programme's elective courses.
• can analyse central challenges and opportunities within the subject field, with appropriate methods and propose sustainable technical solutions.
• can apply and transfer knowledge to new topics and problems within the subject area, which provides a foundation for continuous renewal and expansion of competence within sustainable energy technology.

Skills
The candidate ...
• can analyse problems and perform advanced calculations, measurements and analysis related to energy systems and carriers.
• can maintain a critical perspective towards data from measurements and simulations, evaluate precision and accuracy and draw own conclusions based on assessment of setup and results.
• can analyse relevant theories, methods, and interpretations within the fields of energy and sustainability.
• can independently apply appropriate methods for research and professional development of practical and theoretical case studies within sustainable energy technology.
• can complete and reflect upon a bounded research project on a theme related to sustainable energy technology, both independently and with supervision, which satisfies fundamental research ethical norms.

General competence
The candidate ...
• can analyse environmental, social, and economic consequences of products and solutions within the subject field from a life cycle perspective
• can apply relevant expressions and concepts for communication of their own work and assessments using the subjectspecific forms of expression

• can analyse cases and transfer knowledge and skills to new problems and challenges within energy and sustainability, whilst showing respect for ethics, openness, and reliability within their own work
• can discuss and disseminate results and knowledge about sustainable energy technologies and can contribute to increasing the visibility of a technology's impact and consequences to various target audiences, both written and orally, in Norwegian and English
• can work independently and in interdisciplinary groups, as well as reflect upon own academic conduct.
• has technical grounding for active participation in innovation and innovative processes, based on in-depth knowledge and skills in sustainable energy technology.

Læringsutbyttebeskrivelsen

En kandidat med fullført utdanning skal ha følgende læringsutbytte definert i kunnskaper, ferdigheter
og generell kompetanse:

Kunnskaper

Kandidaten …
K1) har avansert kunnskap om konstruksjon, materialer for og design av energisystemer.
K2) har inngående kunnskap om energikilder, om teknologi for høsting og konvertering av energi og om ulike energibærere med vekt på energieffektivitet og bærekraftig bruk av energi.
K3) har dybdekunnskap innen et utvalg av studieprogrammets valgbare fordypninger.
K4) kan analysere sentrale utfordringer og muligheter innen fagfeltet med egnete metoder og foreslå bærekraftige tekniske løsninger.
K5) kan anvende og overføre kunnskap til nye tema og problemstillinger i fagområdet som gir grunnlag for kontinuerlig oppdatering og utviding av kompetansen i bærekraftig energiteknologi.

Ferdigheter

Kandidaten …
F1) kan analysere problemstillinger og gjennomføre avanserte beregninger, målinger og analyser relatert til energisystemer og energibærere.
F2) kan forholde seg kritisk til data fra målinger og simuleringer, drøfte presisjon og nøyaktighet og trekke egne konklusjoner basert på valg og resultater.
F3) kan analysere relevante teorier, metoder og fortolkninger innenfor området energi og bærekraft.
F4) kan anvende relevante metoder for forskning og faglig utviklingsarbeid på praktiske og teoretiske problemstillinger innen bærekraftig energiteknologi på en selvstendig måte
F5) kan gjennomføre et avgrenset forskingsprosjekt innen et tema relatert til bærekraftig energiteknologi både selvstendig og med veiledning, reflektert og i henhold til forskningsetiske normer.

Generell kompetanse

Kandidaten …

G1) kan analysere miljømessige, samfunnsmessige og økonomiske konsekvenser av produkter og løsninger innenfor sitt fagområde fra et livsløpsperspektiv

G2) kan anvende relevante uttrykk og begreper for formidling av eget arbeid og egne vurderinger med fagets uttrykksformer

G3) kan analysere problemstillinger og overføre kunnskap og ferdigheter til nye problemstillinger og utfordringer innen energi og bærekraft, samt vise respekt for verdier som etikk, åpenhet og pålitelighet i eget arbeid

G4) kan diskutere og formidle resultater og kunnskap om energiteknologi og kan bidra til å synliggjøre teknologiens betydning og konsekvenser til ulike målgrupper både skriftlig og muntlig på norsk og engelsk.

G5) kan arbeide selvstendig og i grupper i en tverrfaglig sammenheng og reflektere over egen faglig utøvelse

G6) har faglig grunnlag for aktiv deltaking i nytenking og innovasjonsprosesser basert på inngående kunnskap og ferdigheter om bærekraftig energiteknologi.

The accreditation process

NOKUT makes an administrative assessment to ensure that the application and documentation is suitable for external expert review. For applications that have been approved administratively, NOKUT appoints external experts for the evaluation of the application. The external experts have declared that they are legally competent to perform an independent evaluation, and carry out their assignment in accordance with the mandate for expert assessment passed by NOKUT's board, and in accordance with the requirements for educational quality as determined by the Academic Supervision Regulations and Regulations on Quality Assurance in Higher Education. The institution is given the opportunity to comment on the committee's composition.

NOKUT is responsible for the training and guidance of the experts during the entire process. Based on the documentation the expert committee writes their assessment. The expert committee conclude either with a yes or no, as to whether the quality of the educational provision complies with the requirements the Academic Supervision Regulations and Regulations on Quality Assurance in Higher Education. NOKUT also requests that the expert committee advise on further improvements of the programme. All criteria must be satisfactorily met before NOKUT accredits a programme.

If the expert committee recommends accreditation of the programme, the report is sent to the applicant institution, which is then given one week to comment on factual errors. If the committee do not recommend accreditation of the programme, the applicant institution is given three weeks to comment and make smaller adjustments to the programme. The committee receives the institutions comments and submits a revised assessment. The Director of Quality Assurance and Legal Affairs then reaches a final decision about accreditation.

Presentation of the expert committee

The Academic Supervision regulations section 5-6 determine the expert committe requirements for accreditation of study programmes at the bachelor's and master's level.

Professor Viktoria Martin, KTH Royal Institute of Technology

Martin is Professor in Energy Technology with KTH Royal Inst of Technol in Stockholm, Sweden. She has her MSc in Chemical Engineering 1993 from the same university, followed by a PhD in Mechanical Engineering 1998 from the University of Florida. Here research is on Energy Systems, with special focus on the role of sector-coupling, district energy, and the integration of thermal energy storage and heat driven heat pumping technology for sustainable development. She has ample experience in leadership in education, for example as programme director for MSc in Sustainable Energy (KIC InnoEnergy MSc SELECT 2009-2012, and KTH MSc in Sustainable Energy Engineering 2017-2019), director of undergraduate and master education in Energy Technology 2016-2019, master school coordinator of the EIT KIC InnoEnergy 2012-2013, and director of internationalization in education with the ITM school at KTH 2019-2021. Prof Martin is also an active teacher, presently course responsible for master's level courses in Energy and the Environment, and Theory and Methodology of Science for Energy Research.

Professor Peter M. Haugan, University of Bergen

Peter M. Haugan is programme director at Institute of Marine Research, Norway, with responsibility for the IMR Global Development programme as well as professor at the Geophysical Institute, University of Bergen, Norway. He is also past chair of the Intergovernmental Oceanographic Commission (IOC of UNESCO). He has more than 30 years of experience in marine scientific research and international ocean science coordination covering ocean, climate and energy issues. His professional merits include 5 years as research engineer in the petroleum industry in the early 1980ies, active contributions to seagoing and polar oceanography from the late 1980ies, research on climate, carbon cycle and storage of CO2 from he 1990ies, head of institutions, international coordination of marine research infrastructures and science-policy
interface from 2000. He has broad academic interests and has initiated and led research and education efforts in renewable energy including offshore wind and maritime low carbon solutions. Since 2018 he serves as co-chair of the Expert Group for the High Level Panel for a Sustainable Ocean Economy and since 2021 he is seconded part time to the Norwegian Ministry of Foreign Affairs. Haugan has supervised master's and PhD students since 1989.

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