The Research Council of Norway

Evaluation of Mathematics, ICT and Technology 2023-2024

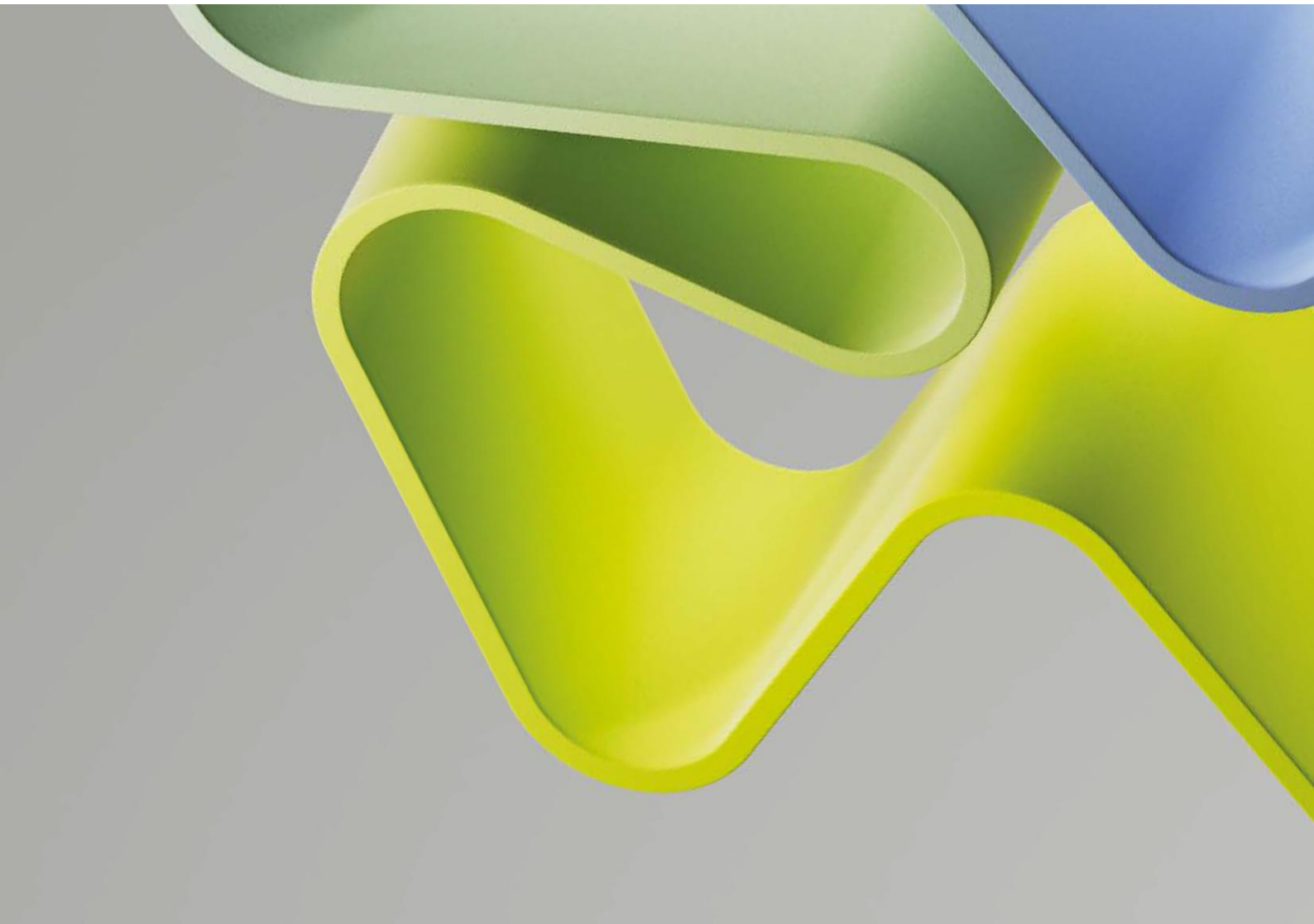
Evaluation Report for Administrative Unit

Administrative Unit: **Faculty of Science and Technology (REALTEK)**

Institution: **Norwegian University of Life Sciences (NMBU)**

Evaluation Committee Higher Education Institutions 2

December 2024



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Statement from Evaluation Committee Higher Education Institutions 2

The members of this Evaluation Committee have evaluated the following administrative units at the higher education institutions within Mathematics, ICT and Technology 2023-2024 and has submitted a report for each administrative units:

- Department of Computer Technology and Computational Engineering (IDBI), UiT The Arctic University of Norway
- Department of Automation and Process Engineering (IAP), UiT the Arctic University of Norway
- Department of Electronic Systems (IES), Norwegian University of Science and Technology (NTNU)
- Department of ICT and Natural Sciences, Norwegian University of Science and Technology (NTNU)
- Department of Information Security and Communication Technology (IIK), Norwegian University of Science and Technology (NTNU)
- Department of Engineering Cybernetics (DeptCybernetic), Norwegian University of Science and Technology (NTNU)
- Department of Information Systems (IIS), University of Agder (UiA)
- Department of Computer Science, Oslo Metropolitan University (OsloMet)
- Faculty of Science and Technology (REALTEK), Norwegian University of Life Sciences (NMBU)
- Department of Science and Industry Systems (IRI), University of South-Eastern Norway (USN)
- School of Economics, Innovation and Technology (SEIT), Kristiania University College

The conclusions and recommendations in this report are based on information from the administrative units (self-assessment), digital meetings with representatives from the administrative units, bibliometric analysis and personnel statistics from the Nordic Institute for Studies of Innovation, Research, and Education (NIFU) and Statistics Norway (SSB), and selected data from the National survey for academic staff in Norwegian higher education and the National student survey (NOKUT). The digital interviews took place in the autumn 2024.

The members of the Evaluation Committee are in collective agreement with the assessments, conclusions and recommendations presented in this report. None of the committee members has declared any conflict of interest.

The Evaluation Committee consisted of the following members:

Professor Jan Canbäck Ljungberg
University of Gothenburg

Professor Bo Wahlberg (Chair)
KTH

Professor Nancy Pouloudi
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Professor Alessandra Costanzo
University of Bologna

Professor Torsten Braun
Universität Bern

Professor Stefan Wermter
University of Hamburg

Description of the Administrative Unit

The Faculty of Science and Technology (REALTEK) was established in 2017 as part of a restructuring of the Norwegian University of Life Sciences (NMBU). Historically, the faculty has evolved from several departments at the former Agricultural University of Norway (NLH) as well the Institute for Agricultural Machinery. As university funding is mainly based on education, the faculty is organised in departments corresponding to study programs. This allowed them to establish successful programs in engineering (siv.ing) over the past three decades with a range of specialisations as well as science teacher training. Research at the faculty focuses on technological solutions to meet national and global challenges related to the environment and natural resources.

The faculty has 25 professors (11% female), 40 associate professors (26% female) and 33 researchers and postdocs (36% female). Furthermore, some 75 PhD students (40% female) are enrolled in the faculty's PhD program contributing significantly to our research. A majority of PhD students are employed at the faculty, while others work at collaborating research institutes, in companies or in public institutions. Almost all professors and associate professors are permanent staff, whereas most other scientific staff are employed in temporary positions. The faculty is aware of the gender imbalance among its research staff and strives to improve the balance by favouring female applicants to equally qualified male applicants (positive action) when hiring new staff in permanent academic positions.

The main research areas at REALTEK are *Engineering for an eco-friendly future*; *Safe, pure, and efficient sources of energy*; *Value adding in biological resources*; *Environmental monitoring and the modelling of technological and biological systems*; *Climate change: causes, consequences, and adjustments*; and *Research related to teaching sustainable development*.

REALTEK has a matrix organisation, where personnel responsibility follows department (i.e., study program) lines, while research groups are organised across departments. Many scientists at the faculty participate in more than one research group, furthering interdisciplinary collaboration. This is facilitated by the co-location of the entire faculty in a single building complex.

At present, REALTEK has 16 active research groups. Three have been put forward: Biospectroscopy and Data Modelling (BioSpec), Material Theory and Informatics (MatInf), and Robotics.

Instead of faculty-specific strategies, all faculties at NMBU develop internal action plans aligned with NMBU's strategy 2023–2030. In the previous strategy period from 2019 to 2023, a key goal of REALTEK was to contribute towards selected UN sustainable development goals (SDGs), as well as to strengthen research and innovation in applied data science, education, and human-centred technology. In this period, the SDGs became an integral part of all activity at the faculty. For example, as part of the internal approval process of project proposals, researchers were asked to describe how their project would contribute to reaching one or more of these goals.

REALTEK encourages its employees to initiate and to participate in national and international research collaborations, bringing together leading experts to address challenging research questions in our fields of expertise.

In recent years, the faculty has established collaborations and secured external funding for collaborative research projects. At present, the faculty coordinates five Horizon 2020/Horizon Europe projects, including two MCSA projects. Examples in Robotics include national and

international collaborations which have led to establishment of the Thorvald agricultural platform (commercialised by Saga Robotics) and more recently the Meat Factory Cell system. As another example, the BioSpec group has a national and international network including both industry and academia. This network spans a diverse array of sectors, including fungal fermentation, food production, agriculture, as well as technology development within the fields of sensors and artificial intelligence (AI).

REALTEK has around 1400 students across 18 study programs. They aim to involve students in research activities and to further strengthen the connection between research and teaching. Faculty members are strongly encouraged to involve master students in ongoing research projects.

As a faculty at the Norwegian University of Life Sciences, REALTEK receives funding from the Ministry of Education and Research (KD) to carry out education and research tasks. REALTEK also receives research funding through competitive grants awarded by external national and international sources such as the Research Council of Norway (RCN) and the European Union (EU). Since 2018, REALTEK has seen an increase in competitive grants awarded by external funding bodies.

REALTEK shares NMBU's strategic ambitions towards ground-breaking research for sustainable development, interdisciplinary collaboration, open science, and the dissemination of knowledge and research results, as well as NMBU's focus on lifelong learning, innovation and creativity. A major generational shift at REALTEK over the past decade has brought a talented and ambitious set of young researchers to the faculty putting them in a good position to boost research in coming years. In alignment with NMBU's strategy, the faculty's action plan for 2023–2025 aims for high-quality research to accelerate the green transition ("REALTEK grønn giv"). They will focus on establishing or participating in RCN-funded research centres and Horizon Europe projects contributing to the green transition. They will also enhance our research dissemination efforts. Increasing collaboration with industry is another goal for the current planning period. Involving students more deeply in our research efforts will contribute to increased research capacity.

Overall Assessment

The administrative unit REALTEK has a substantial student base while at the same time collaborates significantly with industry for research. REALTEK has some successful research groups as evidenced by the standing of some of their international-level researchers and their publications and projects. Many of the projects are interdisciplinary and link research and training. On the other hand, there are also some smaller research groups which are emerging or struggling to keep their research ongoing. Here but also for basic and applied research in general, the support of the ministry for funding PhD student is crucial for small research groups at REALTEK or for new emerging teams and topics. At the same time, links to EU research projects have not yet fully enough exploited and should be considered more in the future.

Regarding the evaluation of the administrative unit in relation to the Terms of References points, below we cover in more detail the evaluation of externally funded research, national and international collaboration, student involvement in research and contribution to open science in the respective sections. In summary, the Evaluation Committee recognises some good drive towards diversification of funding, but the stated EU projects are still small in number for EU research for an administrative unit of this size. The national and international collaborations are added value for the administrative unit and cross-sectoral and interdisciplinary collaboration is encouraged and should lead to further research successes in the unit. Furthermore, a combined strategy of applied research linked to good research by PhD students and Master students promises to be useful to reach these strategic goals. Regarding Open Science, the Evaluation Committee welcomes the various NMBU publishing agreements for Open Access and funds in the budget for Open Access for uncovered publishing routes.

REALTEK has an academic environment characterised by some established research groups and the presence of some highly ranked international researchers. Its involvement in projects, both nationally and internationally, underscores its significant contributions to the field. The commitment to interdisciplinary collaboration is evident through its participation in various cross-disciplinary projects, both within the university and with external partners. Student innovation is actively encouraged through the implementation of student research labs and REALTEK maintains strong ties with industry and relevant partners through collaborative research projects.

The administrative unit faces several challenges that could impact the effectiveness of the overall research environment. The reduction in ministry-financed PhDs poses a significant challenge to research activity at the faculty. Additionally, the university's financial situation has become more demanding with reduced income and increased costs, potentially leading to a decrease in research funding in favour of student education. Furthermore, the university faces challenges in complying with international standards for research data management, and funding regulations. Addressing these challenges through effective research management and transparent processes will be crucial to mitigate negative effects and maintain the institution's research capabilities. Overall and in addition, REALTEK could consider the following recommendations.

The Terms of Reference for the administrative unit is attached to the report.

Recommendations

- Evaluation Committee acknowledges and recommends that public ministry funding is key for basic and applied research and in particular for innovation for new research areas.
- The Evaluation Committee recommends considering models to compensate reduced public funding by the ministry, for instance by industry collaboration, graduate student involvement and international EU projects.

- The Evaluation Committee recommends continuing and developing the good diversification of the research funding in the unit.
- The Evaluation Committee recommends fostering interactions between the many research groups, and to consider strategies for synergies arising between them, for instance towards the started green transition focus.
- The Evaluation Committee recommends evaluating how administration and processes can support this diversity of research groups.
- The Evaluation Committee recommends strengthening EU and international collaborations, for instance in areas of expertise like agricultural robotics, neural computation or biospectroscopy.
- The Evaluation Committee recommends involving more Master and PhD students in the research projects.
- The Evaluation Committee recommends continuing and extend the collaboration on national and international research infrastructure.
- The Evaluation Committee recommends maintaining current activities towards strengthening Open Science and Open Access towards major journals in the field of the administrative unit.
- The Evaluation Committee recommends developing a strategy to maintain young talent in the long run, given the competition with other institutions.
- The Evaluation Committee recommends considering strengthening recruitment and inclusion of international researchers and professors.
- The Evaluation Committee recommends considering strategies how to increase the proportion of female staff at higher rank.

1. Strategy, Resources, and Organisation of Research

The Faculty of Science and Technology, referred to as REALTEK, is a faculty at the Norwegian University of Life Sciences (NMBU) and has about 240 employees. REALTEK focuses on education and research in science and technology aimed at promoting sustainable development, interdisciplinary collaboration and the dissemination of knowledge, which relate also to the general NMBU research strategy.

As an overall aim REALTEK aims to focus on research that contributes to speeding up the green transition and to contribute towards reaching selected UN sustainable development goals. Their 15 research groups are diverse, covering a range of research topics which have developed mostly bottom-up by researchers driving their research topics, out of which the three Robotics group, the Biospectroscopy and Data Modelling group (BioSpec) and the Material Theory and Informatics group (MatInf) are particularly standing out and spearheading the research effort.

1.1 Research Strategy

The strategic goals of the Norwegian University of Life Sciences are related to “Investing together in a sustainable future”. This general goal is further detailed based on research for sustainable development, interdisciplinary collaboration, lifelong learning, open science, creativity and the dissemination of knowledge. These therefore constitute very valuable goals and areas which cover the strategy at the institutional level.

The Faculty of Science and Technology (REALTEK) directly relates their strategy to these institutional goals of NMBU and names sustainable development, interdisciplinary collaboration, open science, and the dissemination of knowledge as their goals. Overall, it is stated in the REALTEK strategy that the aim is that the Faculty of Sciences and Technology

develops research-based knowledge and educates the professionals needed to reach the UN's sustainable development goals. In this way the faculty wants to contribute to speeding up the green transition.

In general, in the view of the Evaluation Committee, this research strategy contributes to developing the research environment and promoting high quality and productivity in research. In terms of actioning this research strategy, there is a continued collaboration with industry, but more Master's students should be involved in the research projects. Such a combined strategy of applied research linked to good research based on PhD students and Master students promises to be useful to reach these strategic goals.

Recommendations to the administrative unit:

- Involve more Master's and PhD students more in the research projects
- Endeavour to further link the many research groups together, and the strategies for synergies arising between them, for instance towards the started green transition focus.

1.2 Organisation of Research

The administrative unit REALTEK is a substantial research entity and has about 240 employees in its research groups. There is a dean, a faculty administration, faculty technical workshop, and a research committee in support of the organisation of research. The administrative unit has a general strategy for organising and supporting its diverse research activities and recruitment.

Regarding internationalisation there is a strategy for international research cooperation which at the University level lists some EU and ERC successes which the Evaluation Committee regards as positive at university level. The other named international collaborations of the University are rather restricted in number and scope (University of Minnesota, Peder Sather Centre for Advanced Study are listed) and such strategic partnerships based on memorandum of understanding could be extended for the administrative unit REALTEK. In the administrative unit REALTEK, the self-assessment report states that there are three EU projects funded by the EU and coordinated in the faculty.

Regarding graduate training, the organisation facilitates education of master students, training and mentoring of PhD candidates and post-docs/young researchers. The administrative unit has 1400 students and a substantial number (18) of study programs.

There are overall 15 active research groups, and they contribute to the institutional strategies and objectives of sustainable research directly. Three main research groups are particularly put forward in this evaluation (Biospectroscopy and Data Modelling (BioSpec), Robotics, and Material Theory and Informatics (MatInf)) but also several other directly contribute to the sustainable development goals, including for instance Digital Electrical Power Systems, Process Technology and Data Science in Water Treatment, Resource Recovery, Solar Energy, Water and Health, among others. Although some of these groups are small in size, the focus on sustainable development is prominent and consistent within the research organisation.

Recommendations to the administrative unit:

- The research groups are diverse in their topics and different in their portfolios and sizes. Evaluate whether and how administration and processes can support this diversity of research groups.

1.3 Research Funding

The administrative unit REALTEK has an active research base with 39% of research funding from external sources in 2022 coming from the Research Council of Norway, 28% from the European Union, 30% from other national and international sources and 3% from contract research. Overall, the Evaluation committee regards this as a good spread of research funding income from different sources.

Most of the research grants came from the RCN and the Faculty has a substantial number of RCN projects. In addition, there have also been several research projects funded by other Norwegian agencies. The Evaluation Committee regards this as a good diversification of the research funding in the unit. At the same time the number of ministry-funded PhDs has decreased according to the assessment report and the income of the university has been reduced.

In terms of EU research, the assessment report states two coordinated EU projects and 1 MSCA postdoc fellow (at a different location, the same assessment report also states two MSCA Postdoctoral Fellowships). Although the assessment report also mentioned several Erasmus+ projects (which are usually also geared more to teaching), the Evaluation committee regards the stated EU projects as still small in number for EU research for an administrative unit of this size. Furthermore, Erasmus+ projects produce much less research traction compared to ERC or EU project research.

Recommendations to the administrative unit:

- Continue and develop the good diversification of the research funding in the unit.
- Consider models to compensate reduced public funding by the ministry, for instance by industry collaboration, graduate student involvement and international EU projects. (However, the Evaluation Committee also acknowledges that public ministry funding is key for basic and applied research and innovation.)

1.4 Research Infrastructures

The administrative unit REALTEK participates in or hosts national and international research infrastructures. NMBU lab facilities at REALTEK are operated by a group of 15 engineers and technicians which demonstrates the commitment and necessity of staff for running substantial technical laboratories. REALTEK research also encourages staff to adhere to the FAIR principles in data management.

Examples for participation in national infrastructure include Sigma2, which is a national e-infrastructure for computational sciences in Norway. In particular for the growing needs of data science and artificial intelligence such access to large computing resources and high-performance computing is needed for the sustainable development research. On the other hand, for more specific robotics research, for instance agricultural robotics at NMBU in the robotics group, there is no such robotics infrastructure available yet and the team develops, jointly with its collaborators, own solutions for Norway and EU.

One particularly active lab at REALTEK is the Biospectroscopy Laboratory and this research group has actively used the international synchrotron facility. Furthermore, there are several other international collaborations and infrastructures, e.g. the neuroscience research group has been involved in the Human Brain Project and the NEST simulator which has been somewhat used in the research community although it is not a main-stream deep learning AI neural network system. Overall, the Evaluation Committee welcomes this involvement of the main research groups in various national and international infrastructure.

Recommendations to the administrative unit:

- Continue and extend the good collaboration on national and international research infrastructure.

1.5 National and international collaboration

The administrative unit REALTEK encourages research employees to initiate national and international cooperations, as evidenced for instance in the Robotics Thorvald agricultural platform, BioSpec group network, and the Research network Water Harmony. Also, cross disciplinary research is encouraged in order to foster collaborations. The Thorvald agricultural platform is seen as a good example by the Evaluation Committee for national and international collaboration in a focused technical domain. In this case there are collaborations at the national but also the international level, for instance with the University of Lincoln in the UK. Other research groups like the BioSpec research group also have international and national links to cooperating partners.

The Evaluation Committee acknowledges that the collaboration profile meets the goals of the administrative unit, but the EU collaborations should be strengthened compared to the national and RCN collaborations. The national and international collaborations are added value for the administrative unit and cross-sectoral and interdisciplinary collaboration is encouraged and should lead to further research successes in the unit.

Recommendations to the administrative unit:

- Strengthen EU and international collaborations, for instance in areas of expertise like agricultural robotics, neural computation or biospectroscopy.

1.6 Research staff

According to the assessment report, REALTEK has a substantial staff base with overall 240 staff. There are 25 professors, 40 associate professors, 33 researchers and postdocs and 47 PhD candidates employed by the faculty and 75 if including PhD candidates at external institutions. About one third of the research staff at REALTEK are PhD students. Women are still somewhat underrepresented, especially at higher rank while there are about 40% female out of the PhD candidates. However, the administrative unit is aware of some of the gender imbalances and tries to improve the balance.

Staff is generally encouraged to go to international conferences, short stays and sabbaticals are also possible. The Evaluation Committee welcomes that all new scientific employees at REALTEK are assigned a PhD student for supporting the research. Although a single PhD student is certainly helpful to get research started, for more sophisticated, technical or experimental topics, one PhD student is also very limited as a support and more substantial seed funding is needed for technical areas like starting a robotics group.

Some research groups not yet running at full capacity. While the number of 75 PhD candidates is substantial, given the number of associate and full professors, the number of researchers, postdocs and PhD students could be larger.

Recommendations to the administrative unit:

- Develop a strategy to maintain young talent in the long run, given the competition with other institutions
- Recruitment and inclusion of international non-Norwegian researchers and professors

- Consider strategies how to increase the proportion of female staff at higher rank

1.7 Open Science

The administrative unit's policies, approaches and activities to open sciences are summarised in the self-assessment report. NMBU adheres to national policies and guidelines for open access including the Ministry of Education requirements. NMBU has an open institutional archive Brage where all doctoral and MSc theses are stored and made accessible.

The most important contributions towards Open Science include various NMBU publishing agreements for Open Access and there are additional funds in the annual budget for Open Access for uncovered publishing routes. NMBU open research data can be made accessible in DataverNO and the management of data is following FAIR principles and makes use of data management plans.

While the unit's policies are summarised, the information on ownership of research data and confidentiality is not yet particularly covered in the summary of the self-assessment although data management plans are mentioned.

Recommendations to the administrative unit:

- Maintain current activities towards strengthening Open Science and Open Access towards major journals in the field of the unit of assessment.
- Clarify ownership of research data and confidentiality.

2. Research production, quality and integrity

The NMBU REALTEK research is organised around three overall research focus areas (Biospectroscopy and Data Modelling (BioSpec), Robotics, and Material Theory and Informatics (MatInf)). Based on the self-assessment report, the descriptions of the research subtopics are:

- Geomatics: aims at remote sensors and radars, geographical analysis, geospatial big data exploration, gravimetry to determine sea level, 3D modelling for building information models, BIM and navigational calculations.
- Mechanics and process engineering: aims at robotics, applied green technologies, biorefining, production techniques for aquaculture, intelligent transport systems, robots for the maintenance of high voltage lines, and robots for agriculture.
- Applied mathematics: aims at applied and computational mathematics, system biology, physics, engineering, and data analysis.
- Natural sciences: aims at energy physics, environmental physics and data science, biophysics and data science, biorefining, mechanics and process engineering, solar power and solar heating, power systems, molten salt physics, biofuels, field stations for bioclimatic studies, hyperspectral imaging, new digital power systems, neural simulation technology, neurophysics, deep learning and machine learning in medical diagnostics, and reactor and catalysis engineering.
- Learning and teacher education: aims at education for sustainable development, research-based education with a clear focus on sustainability. Much of the research is closely related to practice, and action research is a key research strategy.
- Construction: aims at structural engineering, building management and procurement strategies, universal design, school buildings, daylight, sun shading and views,

timber construction, air tightness, climate impacts on buildings and infrastructure, energy in buildings, and decomposition of building materials.
- Water and environmental engineering: aims at purification of drinking water and wastewater, transportation of drinking water and wastewater, urban hydrology, flooding and local surface water management, efficient recycling of resources in wastewater, rapid digitalisation in the global water sector.

NMBU adheres to national and international research ethics standards and has established its own ethical guidelines, emphasising principles like respect, fairness, and integrity. The university's Research Ethics Committee advises on ethical issues, promotes discussions about research ethics, and addresses cases of scientific misconduct. Good to see that a mandatory course in research ethics is required for all PhD students to ensure understanding of ethical practices. Additionally, NMBU encourages participation in its Research Ethics Forum, which facilitates discussions on ethical issues among researchers at all career stages, fostering a strong ethical culture within the institution.

Regarding the NIFU reports (The NIFU statistics go only until 2022). We can also see that there had been a general trend from 2013 to 2020 in increasing the Gold OA publications and decreasing the Not OA publications. However, this healthy trend was reversed from 2021 and 2022 and in 2022 there were 68.8% of the publications NOT OA and only 13.9% Gold OA. The Evaluation Committee therefore recommends considering to increasing the rate of OA publications.

2.1 Research quality and integrity

In the administrative unit REALTEK there are many diverse research groups of smaller and larger size and different scope. Three major research groups are clustered and put forward and their evaluations are presented in the following.

Research group Robotics Group overall assessment

The Robotics Group aims to lead in agricultural robotics through a sustainable blend of education and research. Key objectives include advancing agricultural robotics, establishing relevant education and training topics, broadening expertise in related fields, and supporting university and faculty-level strategies. The group has achieved significant milestones in these objectives and has gained international recognition with collaborations across Europe and partnership agreements with institutions in Brazil, the UK, and others, which are the most significant strengths of the group. The Research Group also focuses on human-robot collaboration, sensing, control, learning, design, and applications, achieving tangible advancements in each area. Notably, innovations like the Thorvald II platform and "Meat Factory Cell" concept stem from their research. Members regularly publish in international conferences and medium/good academic journals, and the group prioritises industry collaboration for developing new robotic and automation technologies. The Robotics Group has overseen 17 projects funded by national agencies and the EC, predominantly centred on research and innovation in robotics technology. While focused on developing and testing new methods and technologies, only a minority involved basic research, yielding commendable results on par with leading international groups. This is the main weakness of the research group (lack of basic research).

Research group Biospectroscopy and Data Modelling (BioSpec) overall assessment

BioSpec group defined three directions as benchmarks, focused on funding, establishing itself as a leading research centre, and ambitious scientific directions. Such strategic plan is coherent and well chosen, with each aspect elaborated and discussed in the self-

assessment text, outlining the current position and the feasibility of the plans. While the first two benchmarks are suitably quantitative, the third one is not really a benchmark, being more an aspiration. The group reports a number of research projects, being involved either as a participant or as a coordinator. This includes coordination of the EU-Project: PHOTOONFOOD that positioned the group among the important EU initiatives. The funding mainly comes from research councils or Horizon programmes, but in spite of focus on applied research, there is no evidence of any substantial funding from industry. The team has a good publication record with papers mainly appearing in specialist journals and intends to build the dissemination aspect further targeting higher impact journals. It plans to expand in the field of AI for bioprocesses, thus expanding into the topical areas of AI and Machine Learning. BioSpec appropriately aims to enhance the stability of funding situation and solidify its position as a strong research centre, actively pursuing strategic initiatives and collaborations.

Research group Material Theory and Informatics (MatInf) overall assessment

There is a good environment to lead high level interdisciplinary research, in terms of facilities (supercomputing clusters) and collaboration with other groups (in local academia and industry). The project acquisition and publication record are relatively low, in the last year, despite the small size and young age of this group. The quality of publications is fairly good as most of publications are in Q1/Q2 journals, where the group members are the first authors. The grant amount has been significantly increasing since 2020. This group had no international or industrial funding, up to 2022. The resource portfolio can be diversified in the coming evaluation period, however, because this group began two EU projects recently and has an industrial network. The social contribution is relatively weak should be improved. The information about the use and access of the open-source codes is missing and it is difficult to evaluate this criterion.

3. Diversity and equality

The administrative unit REALTEK focuses on three valuable key points to address protection against discrimination and to ensure equal treatment and opportunities for its employees: a value-driven organisational culture; the intention to increase the number of women in higher academic positions; and the inclusion of non-Norwegian speakers.

The Evaluation Committee welcomes that the faculty is committed to a value-driven organisational culture that promotes diversity, equality, and the prevention of discrimination through various strategies, including culture mapping and value discussions. To increase the representation of women in higher academic positions, the faculty implements transparent recruitment practices and addresses unconscious biases while supporting female associate professors in their advancement to full professor roles.

Additionally, the faculty focuses on inclusivity for non-Norwegian speakers by providing intensive Norwegian language training for staff required to teach in Norwegian and offering necessary resources in English for PhDs, postdocs, and researchers. Various more detailed references to equality, diversity and inclusion as well as an Action plan for gender equality are provided. Overall, the good work started towards diversity and equality should be continued to increase the number of women in higher academic positions and to foster the inclusion of non-Norwegian speakers.

4. Relevance to institutional and sectorial purposes

The submitted self-assessment shows that REALTEK has around 1400 students in 18 study programs and is the faculty with the most students at NMBU. REALTEK´s activities are cantered around higher education and to conduct research at a high international level. The research is mostly applied. The Evaluation Committee sees as a good example the robotics research which is on applied agricultural robotics rather than basic research and theory for robotics. In this way REALTEK aligns well to the needs in industry and job opportunities and education of the graduate students in a growing future market. At the same time there is successful basic research in other areas for instance in neuroscience and neurocomputing.

Training and mentoring are supported by career opportunities for young researchers. For instance, all new staff at REALTEK get a PhD student assigned if staff are working as associate professors. Career opportunities are also supported in particular for female staff in the recruitment and promotion facilities to full professorship. Regarding training there is also a NMBU course on supervising MSc and PhD students.

Regarding sustainable development, REALTEK's strategy has been to contribute towards selected UN sustainable development goals. The research is mostly applied with support also of the Technology Transfer Office (TTO). It is good to see that faculty encourages student innovation and links to companies. However, after initial proof of concepts often the commercialisation is stopped or is left to the companies.

5. Relevance to society

The administrative unit is a faculty of Norwegian University of Life Sciences with a focus on sustainability and contributing to the transition to a green society. The unit focuses on sustainability in education as well as in research.

REALTEK contributes to society based on its research projects, student education and links to Norwegian industry. Research is often on the applied side of research and thereby contributes to the applications needed in industry.

5.1 Impact cases

Comments to impact case 1: Simulation of brain activity as part of EU Human Brain Project

The Human Brain Project (HBP) was a major European scientific research initiative that ran from 2013 to 2023, funded by the EU. NMBU was taken part in this initiative. The Computational Neuroscience group at REALTEK contributed to the development of a brain simulator NEST for large-scale simulations of spiking neural networks. Different from today's standard deep learning neural networks, spiking neural networks have a better time-dependent and more detailed temporal processing of a single neuron or assemblies thereof. Another contribution has been the development of the software LFPy for predicting electric and magnetic brain signals.

The NEST (NEural Simulation Tool) simulator has influenced the AI and computational neuroscience communities since there are not many robust platforms for simulating spiking neural networks. NEST is an open-source tool, has high temporal precision and supports many specific neuron models and many types of synapses. The main impact of the project has been in making contributions to the EBRAINS infrastructure of the HBP project.

Comments to impact case 2: Robotic “Meat Factory Cells” for automation of meat processing plants

The project Meat Factory Cells is motivated by the Norwegian meat industry, who aimed for exploring new ways of achieving meat automation for Norway. Researchers at the NMBU REALTEK Robotics Group are exploring new methods to previous meat processing, focusing on automation that is economically scalable. The Meat Factory Cell (MFC) concept integrates robotics, smart sensor technology, and AI to enhance processing efficiency. NMBU has played a pivotal role in developing this concept from initial ideas to an industrial prototype, aiming to innovate and optimise meat processing practices. This impact case is strong in its motivation of relevance for the Norwegian market.

Comments to impact case 3: Biodiesel production for aviation

The motivation for this Biodiesel project was to develop a new process technology to produce sustainable fuel and to use a renewable bio-based catalytic material produced from waste sources. This approach has a large impact for reducing the cost for the production of a renewable fuel as well as for developing a new methodology to produce high-value by-products of jojobyl alcohols. Besides the impact for alternative fuel production, there has been innovative added value for the by-products, but also several successful PhD thesis topics, proposals and grants.

Comments to impact case 4: Spectroscopy and machine learning for bioprocess development

The BioSpec research group has done very good research in bioprocess technology, focusing on fermentation to produce high-value chemicals. They have significantly contributed to industrial fungal fermentation as part of a biorefinery concept and successfully implemented spectroscopic monitoring techniques at various scales, from sub-cellular to population levels. A comprehensive platform has been developed for executing microbial processes efficiently, enhanced by artificial intelligence to create digital models for monitoring and optimising these processes. The group has published many scientific papers and coordinated approximately 20 projects funded by the NFR and EU, marking a substantial impact in their field.

Methods and limitations

Methods

The evaluation is based on documentary evidence and online interviews with the representatives of Administrative Unit.

The documentary inputs to the evaluation were:

- Evaluation Protocol that guided the process
- Terms of Reference
- Administrative Unit's self-assessment report
- Administrative Unit's impact cases
- Administrative Unit's research groups evaluation reports
- Bibliometric data
- Personnel and funding data
- Data from Norwegian student and teacher surveys (only for HEIs)

After the documentary review, the Committee held a meeting and discussed an initial assessment against the assessment criteria and defined questions for the interview with the Administrative Unit. The Committee shared the interview questions with the Administrative Unit two weeks before the interview.

Following the documentary review, the Committee interviewed the Administrative Unit in an hour-long virtual meeting to fact-check the Committee's understanding and refine perceptions. The Administrative Unit presented answers to the Committee's questions and addressed other follow-up questions.

After the online interview, the Committee attended the final meeting to review the initial assessment in light of the interview and make any final adjustments.

A one-page summary of the Administrative Unit was developed based on the information from the self-assessment, the research groups' evaluation reports, and the interview. The Administrative Unit had the opportunity to fact-check this summary. The Administrative Unit approved the summary with minor adjustments.

Limitations

The Committee judged the information received through documentary inputs and the interview with the Administrative Unit sufficient to complete the evaluation.

List of administrative unit's research groups

Institution	Administrative Unit	Research Groups
The Norwegian University of Life Sciences	The Faculty of Science and Technology	Robotics Group
		Biospectroscopy and Data Modeling (BioSpec)
		Material Theory and Informatics (MatInf)

Terms of Reference (ToR) for the administrative unit

The board of the Faculty of Science and Technology, NMBU, mandates the evaluation committee appointed by the Research Council of Norway (RCN) to assess the Faculty of Science and Technology based on the following Terms of Reference.

Assessment

You are asked to assess the organisation, quality and diversity of research conducted by the Faculty of Science and Technology as well as its relevance to institutional and sectoral purposes, and to society at large. You should do so by judging the unit's performance based on the following five assessment criteria (a. to e.). Be sure to take current international trends and developments in science and society into account in your analysis.

a) Strategy, resources and organisation
b) Research production, quality and integrity
c) Diversity and equality
d) Relevance to institutional and sectoral purposes
e) Relevance to society

For a description of these criteria, see Chapter 2 of the mathematics, ICT and technology evaluation protocol. Please provide a written assessment for each of the five criteria. Please also provide recommendations for improvement. We ask you to pay special attention to the following 4 aspects in your assessment:

1. Externally funded research

2, National and international research collaboration

3. Involvement of students in research and innovation

4. Contribution to open science

In addition, we would like your report to provide a qualitative assessment of the Faculty of Science and Technology as a whole in relation to its strategic targets. The committee assesses the strategy that the administrative unit intends to pursue in the years ahead and the extent to which it will be capable of meeting its targets for research and society during this period based on available resources and competence. The committee is also invited to make recommendations concerning these two subjects.

Documentation

The necessary documentation will be made available by the mathematics, ICT and technology secretariat at Technopolis Group.

The documents will include the following:

- a report on research personnel and publications within mathematics, ICT and technology commissioned by RCN
- a self-assessment based on a template provided by the mathematics, ICT and technology secretariat

Interviews with representatives from the evaluated units

Interviews with the Faculty of Science and Technology will be organised by the evaluation secretariat. Such interviews can be organised as a site visit, in another specified location in Norway or as a video conference.

Statement on impartiality and confidence

The assessment should be carried out in accordance with the Regulations on Impartiality and Confidence in the Research Council of Norway. A statement on the impartiality of the committee members has been recorded by the RCN as a part of the appointment process. The impartiality and confidence of committee and panel members should be confirmed when evaluation data from the Faculty of Science and Technology are made available to the committee and the panels, and before any assessments are made based on these data. The RCN should be notified if questions concerning impartiality and confidence are raised by committee members during the evaluation process.

Assessment report

We ask you to report your findings in an assessment report drawn up in accordance with a format specified by the mathematics, ICT and technology secretariat. The committee may suggest adjustments to this format at its first meeting. A draft report should be sent to the Faculty of Science and Technology and the RCN. The Faculty of Science and Technology should be allowed to check the report for factual inaccuracies; if such inaccuracies are found, they should be reported to the mathematics, ICT and technology secretariat within the deadline given by the secretariat. After the committee has made the amendments judged necessary, a corrected version of the assessment report should be sent to the board of the Faculty of Science and Technology and the RCN no later than two weeks after all feedback on inaccuracies has been received from the Faculty of Science and Technology.

Appendices

1. Description of the evaluation of EVALMIT
2. Invitation letter to the administrative unit including address list
3. Evaluation protocol
4. Template of self-assessment for administrative unit (short-version)

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