

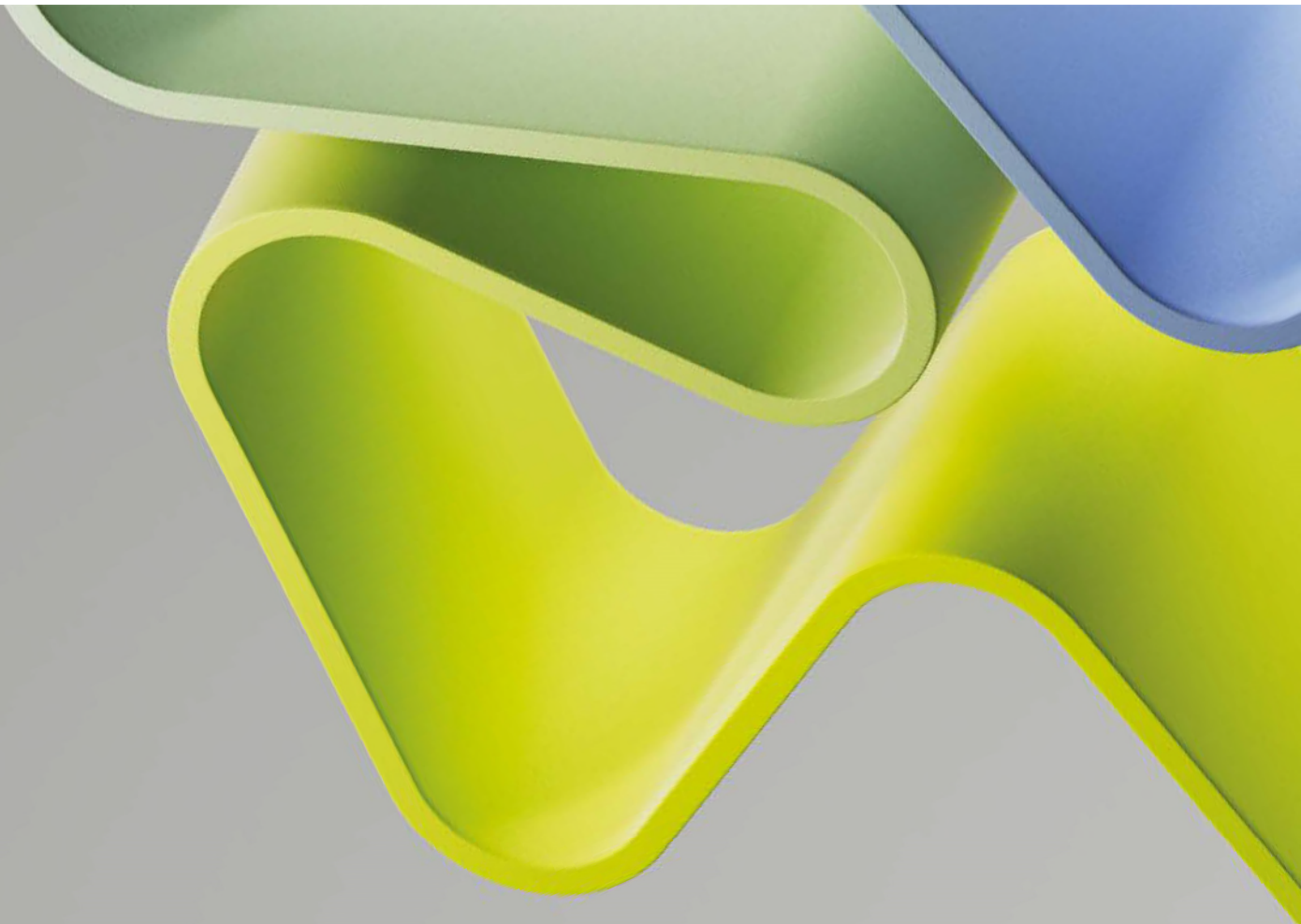
Evaluation of Natural Sciences 2022-2024

Evaluation report

Department of Chemistry

**University of Tromsø - Faculty of Science and
Technology**

January 2024



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Statement from Evaluation Committee II

The members of this Evaluation Committee have evaluated the following administrative units at the higher education institutions within natural sciences in 2022-2023 and submitted a report for each administrative unit:

- Department of Chemistry, Norwegian University of Science and Technology
- Department of Physics, Norwegian University of Science and Technology
- Department of Chemical Engineering, Norwegian University of Science and Technology
- Department of Materials Science and Engineering, Norwegian University of Science and Technology
- Department of Geoscience, University of Tromsø
- Department of Chemistry, University of Tromsø
- Department of Physics and Technology, University of Tromsø
- Department of Energy Resources, University of Stavanger
- UNIS – The University Centre in Svalbard

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

The Evaluation Committee has consisted of the following members:

Professor **Amelie Hagelauer** (chair)

Technical University of Munich, Germany

Dr. **Eric Deville**

IFP Energies Nouvelles, France

Professor **Christian Rugg**

Federal Institutes of Technology ETH Zurich,
Switzerland

Professor **Guido Mul**

University of Twente, The Netherlands

Professor **Sigridur Suman**

University of Iceland, Iceland

Description of the administrative unit

University of Tromsø – UiT

Department of Chemistry – IK

The administrative unit

The unit employs 83 FTE research staff out of which 11 are professors, 3.7 associate professors/senior lecturers, 9.3 researcher scientists, 15 postdocs, 30 PhD students, 12.6 technical/administrative staff and 1.4 adjunct professors/associate professors. The unit has a broad research focus from physical chemistry to biotechnology. Areas of research are theoretical chemistry, synthetic chemistry, and biological chemistry.

The belonging research groups

IK consists of three research groups – Chemical Synthesis and Analysis research group, Theoretical Chemical research group and Biological Chemistry research group.

The administrative unit works in relation to the unit's strategies

IK's overarching goals are to perform internationally visible research and societal relevant innovative research, attract external funding for basic and innovative research, and to train and give opportunities to the next generation of young chemists. Research is directed towards addressing the societal challenges. This is also reflected in the IK's strategy until 2022, which highlights research that supports sustainable use of resources, sustainable development, and better health and well-being as important research areas. IK's research focus is well-suited to support an increased focus on sustainability, innovation and internationalization.

The unit works in relation to the belonging sector

IK's research activities support several of the sector-specific objectives of UiT as described in the Act for universities and university colleges § 1-1 and the development agreements between UiT and the Ministry of education and research. A considerable amount of research has led to innovation and commercialization in collaboration with partners from industry and private sector. Many researchers are active in a range of outreach activities to disseminate research activities and the importance of research in general to society. The PhD and MSc students educated from the department work as technical staff, researchers, consultants and teachers in BioTech and pharmaceutical companies, chemical industry, hospital, academia, in computer science, programming and research institutes. Lately, IK has started a process to establish competence for research and education supporting the existing and evolving private sectors in the region (CCU, battery technology, environmental analysis, specialty enzymes).

Where the unit will be in the future

IK's research activity supports key priorities of the Norwegian Long-term plan 2019-2028. Research is in line with UN goals for quality education (UN #4), Good Health and Well-being (UN #3), Innovation and Infrastructure (UN #9), Responsible Consumption and Production (UN #12), Climate Action (UN #13), and Life Below Water (UN #14). Regarding the long-term priorities of the plan, IK is particularly active in the areas of climate and clean energy, as well as enabling technologies, where most of the research at the department falls within the domains of biotechnology, nanotechnology as well as also indirectly the domain of ICT through the method-development activities in the theoretical chemistry group.

Overall assessment

The University of Tromsø Department of Chemistry is a sizable unit, which creates significant scientific impact particularly via the Theoretical Chemical research group and Biological Chemistry research group. The latter group is also mainly responsible for creation of societal impact – given the two research impact cases provided by the department. These two groups appear to have a solid foundation for their activities, and have established a good reputation in the national arena. They have a reasonably well-defined focus and a commitment to excellence in research, while in addition - in particular through the Biological Chemistry research group - entrepreneurship has been successful. The department is very active in transforming research ideas into innovations which generate start-ups, many of which have succeeded to become successful businesses. The level of impact of the Chemical Synthesis and Analysis (CSA) research group is not so evident, and the Evaluation Committee does not have a clear view on how this group wants to be distinctive from other organic synthesis and analysis groups in Norway, and what the long-term vision is. CSA has spread out its activities and hired staff that appears to broaden and diffuse their research focus. They do however get significant funding and collaborate on an international level.

The unit closely collaborates with (local) industry and has created spin-off companies. As a unit, the Department of Chemistry has the ambition to embark in (for the unit) less traditional fields of science, including renewable energy and Carbon Capture and Utilization (CCU). This ambition is not unique, and several other institutions (including in Norway, such as, for example, the Chemical Engineering and Materials Science Departments of NTNU) have already running initiatives in these fields.

The governance of the unit is not unique, but functions well, and the leadership has clear ambitions to i) determine the skill-sets of required (additional) staff, ii) enhance the synergy between the activities of the three research groups, and iii) maintain a healthy level of funding for research activities. The collaboration between the three research groups is there, but is challenged by the fact the groups are located in different buildings – therefore the research groups do not regularly meet in social corners, for example.

The challenges the unit faces are mainly related to the basic operational funding, which appears insufficient to cover the salaries of the members of the unit – while the Department is already short on staff available for teaching. Teaching activities are covered by PostDocs, and PhD students. The Evaluation Committee considered the points raised by the unit in their Terms-of-Reference document and have commented on those throughout the report where applicable. The Evaluation Committee has provided its assessment on the synergies between Centres of Excellence and other funding sources and overall procedures in Section 1.3. Research Funding.

Recommendations

Based on the overall assessment of the Department of Chemistry, UiT and considering the requirements for recommendations set out in the Terms of Reference, the Evaluation Committee recommends the following:

- The Theoretical Chemistry group demonstrates important and significant scientific contributions, but should demonstrate more clearly how the group contributes to the overall development/research goals of the unit. Also, a clearer vision should be developed to have the activities/achievements contribute to those of other theoretical groups in Norway, such as at NTNU. The Evaluation Committee anticipates synergies can be found.

- The Biological Chemistry research group is very good at social impact (see case studies) but could improve its scientific prowess and leadership – for example working on their international visibility and partnership in European projects. Generally, the unit could improve international visibility, allowing the unit to participate in European projects.
- The ambition of the unit to increase their efforts (based on the expertise of the Chemical Synthesis and Analysis research group) in the marine sector, is encouraged – given the size or number of fish farming plants, which is increasing in the region.
- Focus on strengthening research efforts in the fields of renewable energy (given Si mines are in the vicinity) is appropriate. The ambition to develop technology for CCU (Carbon Capture and Utilization) should be further discussed. The Evaluation Committee presently does not see which strengths or opportunities the unit wants to capitalize on to provide for a unique contribution in this scientific arena.
- The challenge in staffing for teaching activities could be addressed by hiring staff that is devoted to teaching (Lecturers).
- The administrative unit has put a lot of effort into diversity, gender balance, and inclusion. This is praise-worthy. The Evaluation Committee encourages this activity while also suggesting to ensure the cohesiveness of the research groups.
- Generally (for hiring purposes) the unit could capitalize better on their unique topographical location in the arctic – and what makes the unit unique in their expertise and generation of impact. The administrative unit should work on the international visibility of the unit.

1. Strategy, resources, and organisation of research

1.1 Research Strategy

The department strategy for disciplines focuses on theoretical chemistry, synthetic chemistry, and biological chemistry. The focus has been primarily on excellence (measured in number and quality of publications and PhD theses). Several of the research lines are collaborative between groups at the department or the university, in addition to international collaborations in e.g. antibiotic resistance, cold-adaptation and enzyme design. The case studies clearly indicate that in prior years the focus (of generating impact) has been on the Biological Chemistry research group. The department indicates that it aims to broaden the scope to other SDG's of the United Nations – in particular related to the surplus of renewable energy in Norway and in the region. The unit also has ambitions to divert their research efforts to the capturing and utilization of CO₂. The overall ambition of this Unit is to perform internationally visible innovative research on societal relevant topics. Furthermore, the department aims to train the next generation of well-educated chemists.

1.2 Organisation of research

The way that the unit is governed is by a Head of Department, with accompanying Chairs of Education (HoE) and Administration (HoA). The Head of the Department also has a deputy who is responsible for research related questions – and reports to the HoD. The HoE holds responsibility for the planning of teaching, and HoA is responsible for the budget and daily operations. The department consists of four research groups, which are evaluated as three (Chemical Synthesis and Analysis have merged). Each group has a leader who represents the group in strategic development, and departmental leadership. The PI's are responsible for their research activities, funding, project based education and training. The HoD meets biannually with staff to discuss the UiT status and future directions for research and career development.

UiT requires a very high teaching engagement of the staff. There is a 50/50 division between research and teaching for some faculty members. The HoD is responsible for monitoring the workloads. Balance is not necessarily achieved because of imbalance in competences of the staff. PostDocs with positions that extend over two years are also assigned teaching duties of up to 15% - lowering research output.

1.3 Research funding

Funding of the staff is arranged through external grants (29 FTE), as well as competitive internal grants (22 FTE). The unit indicates this level of external funding is sufficient to maintain a healthy financial situation. To support research activities, the unit has been quite successful in attracting funding. Recent national grants are a Centre of Excellence (Hylleraas Centre for computational chemistry; shared with UiO), an RCN "Toppforsk" grant (Cube3), a Digital Life Norway grant (DIGIBIOTICS), and 9 ground-breaking research projects (CatchMe, MultiDim, PerSpectives, ReMRChem, SusCat, CasCat, NanoAMP, Metalloporphyrins, Phototherapeutics). The administrative unit invests adequate thinking and resource to ensure synergies between the most important awards and Centres of Excellence. This thinking to identify potential synergies should be pursued in the future.

More recently the department has been less successful with grant applications – which is partly due to the decrease in probability of getting proposals granted (e.g., by RCN). This is a major concern of the department – how to increase funding acquired externally. Many new options are being pursued – but predominantly nationally (with RCN). Also, industrial connections are important to secure funding. Many opportunities for higher success may be found in funding through European networks; collaborations may help increase the chances of success. A clear strategy to attract funding for the identified new topics (CO₂ capture – energy research) is not evident to the Evaluation Committee. The Evaluation Committee encourages the department to seek more collaborations. For example, the unit of chemical engineering at NTNU has similar ambitions (and track record) in the field of CO₂ capture, utilization and storage.

1.4 Use of infrastructures

The Sigma2 e-infrastructure is important for several activities at the department. The CSA group uses the National NMR Platform (NNP, host) for structural elucidation, binding studies and dynamics measurements, the Sigma2 e-infrastructure for modelling and NORCRYST for crystallography. For the NNP-2 period starting in 2023, the department has become a full node of the NNP infrastructure. The participation in the NNP-infrastructure is important for activities related to bioprospecting (structure elucidation) and protein NMR. The Unit does not have local access to clean-room/nanolab facilities, even though some new equipment has been purchased. Since travel distances to clean-room/nanolab facilities are long, the unit hopes for construction of a small cleanroom in Tromsø. Infrastructure is maintained with internal funding. Internal funding is also used for strategic investments in infrastructure.

1.5 National and international collaboration

The administrative unit uses collaborations extensively and effectively. Collaborations are with local industry, Norwegian higher education institutions and research institutes. Collaborations offer opportunities to use, for example, nanolab facilities. The international visibility is not so evident to the Evaluation Committee. The unit could increase the number of mobility grants. Mobility is a viable means to increase the international visibility of the unit.

1.6 Research staff

The Evaluation Committee observes that the unit has a high ratio of part time employees – and a large number of graduate students' assistants in teaching. This is necessary due to the size of the department – there are no resources to hire additional staff to increase the teacher/student balance. The heavy load of teaching responsibility is having an impact on scientific output. For example, it is not easy to arrange a sabbatical leave for staying abroad – in relation to the transfer of educational responsibilities. The Evaluation Committee discourages sabbatical leave under the condition that teaching can be done remotely – this is too much of a distraction from research activities. A positive aspect is that the department is able to financially support (inter)national travel – and in that sense supports mobility. ERASMUS+ mobility grants are also used.

There is a significant share of female researchers, which is 23% at the professor level, and very high in the adjunct level at 71%. The gender balance on the PostDoc and PhD student level is 50:50 – providing an almost equal gender representation. Academic staff renewal has been actively used to improve the gender balance, and internal funding used to help bridge funding gaps in external funding for research groups.

The SWOT analysis draws out a decrease in student numbers, lack of funding to hire replacement academic staff for retired staff, and risk of dropping faculty numbers under the critical mass for teaching activities. Reduction of administrative and technical staff is also a concern. The Evaluation Committee encourages the unit to develop strategies to attract new hires.

Language barriers hinder career development specifically for non-Scandinavian speaking employees. Learning curve for new hires in the administrative positions is long.

Generally (for hiring purposes) the unit could capitalize better on their unique topographical location in the arctic – and what makes the unit unique in their expertise and generation of impact. Improving international visibility and enlarging international collaborative efforts could also benefit the unit in attracting new hires.

2. Research production, quality and integrity

Overall, the administrative unit published 66 articles in 2021, or a bit less than their average 75 per year in the 2019-2021 timeframe. The number of open access articles is high. About 70% and 15% of the unit's publications are international and national collaborations respectively. Of the international collaborations about 8% are with top-ranking institutions. The most common publishing venues are in very good inorganic chemistry and physical chemistry journals. The age distribution of the authors of these publications is symmetric around the age group of 40-49 with very little contribution from the age groups of 20-29 and 60-69.

Bibliometric data shows the administrative unit achieved gender neutral author shares in scientific publications in 2021, and over the evaluation period women contributed slightly more author shares than men.

2.1 Research quality and integrity

Research group: Theoretical Chemistry overall assessment

This is an excellent group at the forefront of current theoretical chemistry. Given the difficulties in recruiting young scientists (particularly postdocs) north of the polar circle the productivity of the TCG is remarkable. The work on method development is internationally leading and could be a candidate for highlighting. One of the professor's methodology and software development is outstanding. The TCG works in a variety of fields in computational chemistry, from development of methods and algorithms for advanced spectroscopies to organic chemistry reactions and biological systems. Within each of these fields, the group shows high scientific quality through publications in the major journals of theoretical and/or computational chemistry as well as PhD theses. Importantly, PhD students are trained by a structured program which seems adequate and very helpful for their career. The research work of the group is performed in close collaborations with other groups at IK. Moreover, the activities of the group supply a sizable proportion of the computational chemistry research in Norway. Members of the group are frequently invited to the major international conferences.

Research group: Biological Chemistry overall assessment

The Biological Chemistry group at the Arctic University of Norway is part of the Department of Chemistry. The group consists of two sub-groups, Molecular Biosystems and Bioinformatics (MBB) and Biomolecular and Structural Chemistry (BSC). The group forms a small unit with 5 faculty members. The panel finds that the research group is well-coordinated and well-equipped for their projects. The strategy is well stated and appears well-chosen, in particular in view of their location. The group has been rather successful in attracting external funds for their research. The group has a strong scientific output, as evidenced by their publications. In addition, they have demonstrated strong societal impact (see the cases summarized below).

Research group: Chemical Synthesis and Analysis overall assessment

The Chemical Analysis and Synthesis (CSA) group consists of five separate research subgroups that carry out independent research projects with their own staff, which includes postdocs and PhD students. However, most of these subgroups do not reach the critical mass necessary for high quality research. They do collaborate with one another in joint external research grant projects, and the CSA group holds biweekly meetings focused on scientific topics and information sharing. The research

topics covered by the CSA group are broad, including drug discovery and design, functional nano-scale materials, catalyst development, and biofilms. Rather than having a specific goal, the CSA group's main objective is to become a recognized leader in chemical synthesis and analysis internationally. The CSA's strategy emphasizes educational aspects, particularly researcher training, but lacks a cohesive approach to research activities. The subgroups actively collaborate with several other disciplines, and in some cases, these collaborations even determine which research areas are studied in joint-funded projects. The CSA group works with national and international universities, research institutes, and industry partners.

2.2. Open Science

Full-text copies of scientific articles written by employees and students are uploaded (deposited) in the national register. In 2021 75% of the publications were published as Open Access. UiT has no additional policies regarding publications, open-source software or educational material.

3. Diversity and equality

UiT has an action plan for equality, diversity and inclusion which is followed up by an action plan at the faculty level. The department had focus on supporting female researchers by providing them with PhD positions. UiT and the department has several formal and informal mechanisms to get aware of discrimination or unethical behaviour. New employees are informed about this. Challenges are related to teaching opportunities for non-Scandinavian speaking postdocs and researchers. Inclusion is also aimed at individuals with LGBTQ identity, or non-European ethnical background - UiT has executed many prongs to increase inclusion and diversity. A well appreciated result is that they hired eight female adjunct professors partly to increase the number of visible female role models among teachers and researchers.

4. Relevance to institutional and sectorial purposes

The students graduating at the unit have excellent opportunities to obtain jobs and support the local economy. The unit has various research topics which connect to the local economy – industrial collaborations have been established. An important point is that the student to educator ratio is unfavourable – with various courses provided by PhD students and PostDocs – which might not be beneficial for the level of education – unless these group members are well trained. The broad scope of the unit allows the student a large choice for higher education studies.

Research activity has received lower priority than teaching and research at the unit. The administrative unit could collaborate more extensively and effectively in research, for example with neighbouring departments. Collaborations offer extensions of the local training to national or international quality.

The administrative unit has a strategy in place for research with focus on sustainable development goals, but could be more specific about it.

5. Relevance to society

The administrative unit's research contributes to several UN SDGs, especially in environment protection and health challenges as demonstrated by the below impact cases. There is also a significant contribution to Norway's societal and industrial topics.

Comments to impact case 1

The first impact case is related to the Biological Chemistry research group. The group has been successful in using maritime based enzymes. All in all, 1000 enzyme variants have been screened. Fifteen of these have been subjected to large-scale protein production and purification to confirm the improved activities measured during the screening process. Finally, five variants that performed better than state-of-the-art commercial enzymes have been sequenced to identify the mutations and characterized in detail. One variant stood out and showed an increase in the desired activity by more than 2-fold which surprisingly was caused by a single mutation, i.e., a substitution of only one amino acid residue. Introducing this substitution in homologous DNA polymerases led to the same. Apart from the obvious societal advantages connected to reduced infection risk in critical care, Amicoat employs a staff of 11 persons, of whom 7 are working in R&D in both Tromsø and in the Oslo area publications, educating a variety of PIs and PhD students. Collaboration with (local) companies is appreciated: ArcticZymes Technologies ASA signed an agreement with the university in December 2022. Furthermore the project has led to significant impact so that additional, new projects could be established.

Comments to impact case 2

Founding of a company commercializing antimicrobial technology for medical devices is much appreciated. This appears to be another effort largely related to the activities of the biological chemistry research group. The research has been directed towards antimicrobial peptides, to elucidate their exact mode of action on microorganisms, to understand their medicinal chemistry, potential toxic effect on humans and to derive principles for the utility of antimicrobial peptides to limit the infection risk caused by the use on medical devices.

The impact on health care is obvious – reducing the risk of infection when hospitalized and exposed to medical devices. The publications cited have also appeared in well appreciated journals and create impact.

Apart from the obvious societal advantages connected to reduced infection risk in critical care, Amicoat (a commercial enterprise) employs a staff of 11 persons, of whom 7 are working in R&D in both Tromsø and in the Oslo area.

List of administrative unit's research groups

Institution	Administrative Unit	Research Groups
University of Tromsø	Department of Chemistry	Theoretical Chemistry
		Biological Chemistry
		Chemical Synthesis and Analysis

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 (see appendix 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

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 group assessment, 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.

Appendices (link to website)

1. Description of the evaluation of EVALNAT
2. Invitation to the evaluation including address list
3. Evaluation protocol
4. Self-assessment administrative units
5. Grading scale for research groups

Website: <https://www.forskningsradet.no/tall-analyse/evalueringer/fag-tema/naturvitenskap/>

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