The Research Council of Norway

Evaluation of Mathematics, ICT and Technology 2023-2024

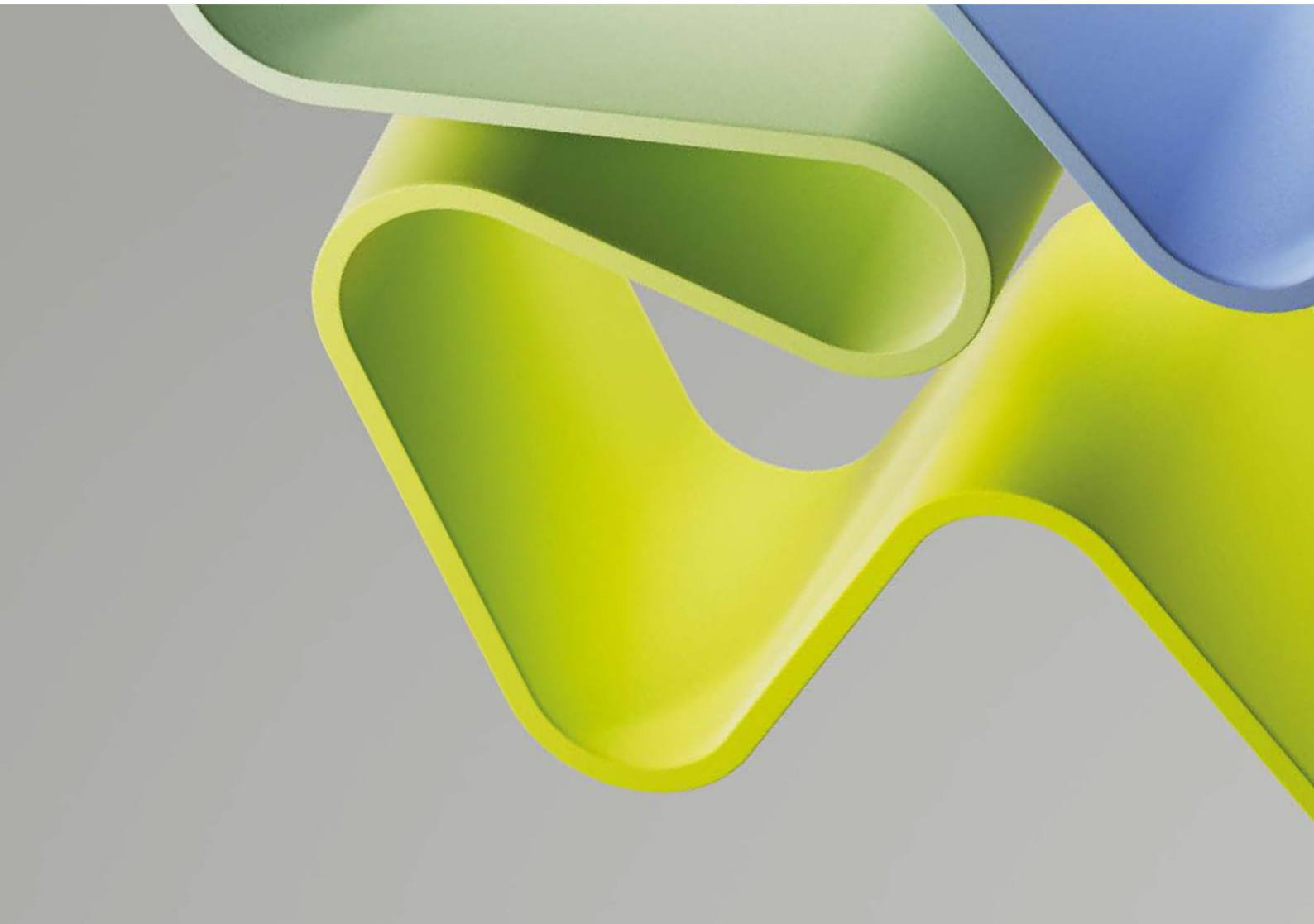
Evaluation Report for Administrative Unit

Administrative Unit: **Department of Geoscience**

Institution: **Norwegian University of Science and Technology (NTNU)**

Evaluation Committee Higher Education Institutions 4

December 2024



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Statement from Evaluation Committee Higher Education Institutions 4

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

- Department of Building, Energy and Material Technology, UiT the Arctic University of Norway
- Department of Architecture and Technology (IAT), Norwegian University of Science and Technology (NTNU)
- Department of Civil and Environmental Engineering (DCEE), Norwegian University of Science and Technology (NTNU)
- Department of Geoscience (IGV), Norwegian University of Science and Technology (NTNU)
- Department of Structural Engineering (KT), Norwegian University of Science and Technology (NTNU)
- Department of Manufacturing and Civil Engineering (IVB), Norwegian University of Science and Technology (NTNU)
- Department of Energy and Process Engineering (EPT), Norwegian University of Science and Technology (NTNU)
- Department of Built Environment (BE), Oslo Metropolitan University (OsloMet)
- Department of Energy and Petroleum Engineering (IEP), University of Stavanger (UiS)
- Department of Mechanical and Structural Engineering and Material Science (IMBM), University of Stavanger (UiS)
- Department of Process, Energy and Environmental Technology (PEM), University of South-Eastern Norway (USN)

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 has consisted of the following members:

Professor Claudio Mazzotti, University of Bologna (Chair)

Professor David Baglee
University of Sunderland

Professor Elsa de Sá Caetano
University of Porto

Professor Sebastian Geiger
TU Delft

Professor Per Heiselberg
Aalborg Universitet

Professor Mohamed Pourkashanian
University of Sheffield

Description of the Administrative Unit

The scientific staff of the Department of Geoscience at the Norwegian University of Science and Technology (NTNU) includes 26 professors, 11 associate professors, 12 adjunct professors, 6 adjunct associate professors, 41 PhD candidates, 4 postdocs, and 6 researchers. The department faces ongoing challenges with gender imbalance across several personnel categories. To address this, the unit is working towards improving gender equality and diversity at all levels, as outlined in its strategic development goals.

The department's management team includes the Head of Department, Deputy Heads for Research and Education, and the Head of Administration. Each research group is led by a Group Leader. The department benefits from a skilled administrative and technical staff, including senior advisors for education and research, as well as support for studies, finance, HR, and communication. Technical staff also participate in student supervision in laboratories and are actively involved in research projects. Research group leaders coordinate their group's research and educational activities, while the groups themselves manage their efforts in education, research, researcher training, outreach, and innovation. These activities are carried out in collaboration with, and supported by, the department management and administrative staff.

The department has a strong profile in applied research. Three main thematic areas have been identified for their ongoing and future activities within both fundamental and applied research and research-based education: Geosciences, Georesources, and Geoinfrastructure.

The research is organised in the following research groups:

- Engineering Geology and Rock Mechanics
- Mineral Production and HSE
- Geology (merged with Geophysics group as of January 2025)
- Geophysics (merged with Geology group as of January 2025)
- Well and Reservoir

The department aligns its activities with the university's strategy, focusing on education, research, innovation, and knowledge dissemination. It has linked its research to three of NTNU's Strategic Research Areas for 2024-2031: Energy, Civil Security, and Ocean and Coast. The department has recently finalised its dedicated strategy for the next five years and is now in the process of implementing it. The strategy's main objective is to advance geosciences research and education to enhance resilience in science and society. This involves interdisciplinary work and integrating diverse data. The new strategy aims to make the department a leading research environment in Geosciences, Georesources, and Geoinfrastructure, excel in student recruitment, attract a diverse workforce, and contribute to public debates. In research, the department aims to lead large collaborative projects, increase EU funding, boost externally financed projects, improve international visibility, and enhance its impact through active roles in national and international boards and committees.

The department has a strong tradition of collaborating with universities, industry, and research institutes, including all major Norwegian universities and several international partners. Key research partners include SINTEF Industry and SINTEF Community, with co-located offices and laboratories facilitating regular interaction. The department also

collaborates with the Geological Survey of Norway (NGU), the Norwegian Geotechnical Institute (NGI), and NORCE. Engineering research groups work closely with industry partners in mining, hydropower, and petroleum, involving guest lectures, adjunct positions, co-supervision of projects, and support for research through national grants and direct cooperation.

Overall Assessment

The Department of Geoscience covers a broad and timely range of fundamental and applied geoscience activities including georesources (energy and mining), geotechnics, geohazards, geophysics,[1] all of which underpin Norway's long-term plans for research and education and are aligned with the United Nation Sustainable Development Goals. This broad range of activities is the result of the merger and colocation of two departments, the Department of Petroleum Engineering and Applied Geophysics and the Department of Geology and Mineral Resources. Although traditionally organised in research groups, the department has recognised that tackling these geoscience challenges needs a more interdisciplinary approach within the departments and through collaboration with university-wide research themes (e.g., NTNU's energy cluster). A strategic name change was finalised in October 2024 to emphasise that the department has a broader remit that reaches beyond more traditional petroleum geoscience.

Throughout 2024, the department has developed a new strategy, using working groups within technical teams, research groups, admin teams, and regular exchange meetings. This strategy defines the high-level targets and ambitions and hence provides an overarching framework. Based on this framework the department is now developing concrete action plans to implement the strategy and continue the path of widening the department's interdisciplinary research priorities. This strategy also affects the department's teaching activities, where traditional petroleum programmes are no longer offered and have been replaced by study programmes that emphasise sustainable technologies. These study programmes enjoy stable student numbers. Considering the many challenges traditional geoscience departments, especially those with a strong petroleum focus, face these days, this strategic approach to future-proof the department's research and teaching is judged very good and timely.

The department has a considerable number of permanent academics (37) and adjunct academics (18), which is an excellent size for a modern geoscience department and likely the result of the aforementioned merger which provides critical mass in key research areas. The academics raise a stable research income of ~74M NOK per year, amounting to approximately 50% of overall department budget; the annual research income of 2M NOK per permanent academic is judged as above-average for a geoscience department.

The research activities at the department greatly benefit from excellent laboratories that were inherited from the two parent departments. These laboratories are supported by permanent staff as well as strong connections to industry and collaboration with essentially all other relevant Norwegian institutions, as evident in the regular participation in many Norwegian research centres and programmes.

Areas where the department appears to be operating behind international benchmarks include the publication track record which has some variability in terms of quality and impact among the different groups, the ratio of PhD students (41) to permanent academic staff (37), the poor gender balance and lack of a clear EDI plan beyond the EDI actions available at the university, the somewhat limited international collaboration and participation in EU projects, the fact that the department is not leading national or international research centres or taking

[1] The research groups Geosciences and Geophysics have been evaluated in Evaluation of natural sciences (EVALNAT 2022-2024).

leading roles in professional societies, and the limited showcasing of the department's research impact and quality.

Despite these shortcomings, the department has a good foundation based on which it should expand its existing strengths. With a strong research strategy and a robust implementation plan, the department should be in a strong position where it can have the stretch goal to become one of Europe's leading applied geoscience departments.

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

Recommendations

1. The main recommendation is to complete the action plan to finalise the implementation of the new department strategy. This action plan must ensure that the individual research groups are incentivised to support and pro-actively engage in the cross-cutting research themes. This plan should include KPIs and/or benchmarks to track the progress of the implementation. The department may want to consider appointing an advisory board that acts as a "critical friend" and not only offers constructive feedback on a regular basis but also supports the department externally, e.g. when asking for more resources at the faculty or university level. The department may also want to consider engaging with other department management teams across Europe (e.g., Imperial College London, TU Delft) that have steered their departments through a period of change during which the departments transitioned from a more traditional petroleum focus to a broader and more modern applied geoscience remit. In addition to finalising the strategy implementation plan, but not necessarily entirely independently from it, the department should:
2. Put a robust action plan together to tackle specific EDI issues and social safety aspects (e.g., inclusivity of field work and excursions) that reach beyond gender balance;
3. Develop a coaching or mentoring approach to support early career researchers within the Department;
4. Use its website and annual reports to showcase the department's impact to society more prominently (it appears that some groups underplay their impact);
5. Focus on internationalisation by participating in and leading more EU projects as well as leadership in Norway, for example by leading bids for RCN centres;
6. Strengthen the dissemination of the more fundamental research results that underpin the applied research by targeting some of the high-impact geoscience journals.

1. Strategy, Resources, and Organisation of Research

The current department is result of merger of two departments in 2017, so it is a relatively new endeavour. The merger resulted in a department of significant size with excellent laboratories that provide critical mass to tackle many important issues in (applied) geoscience. The department has a timely and pertinent focus on three geoscience themes, i.e. georesources, geoinfrastructure, geoscience, to broaden its remit beyond a more traditional petroleum geoscience focus. These themes will require a more interdisciplinary approach where research and teaching bridge across the existing research groups and link into other university-wide activities.

The organisational structure is functional and commensurate to support the day-to-day operation of department of that size. The department has specific roles not just for the department head but also for deputy heads that focus on research and teaching, and which provide the appropriate links to engage with the wider faculty and university processes. Each research group has a head, and the groups have some autonomy. The research groups will need to be incentivised to collaborate more in the cross-cutting themes in the future.

As noted above, an overarching strategic framework has been completed for the department and now an implementation plan is being developed to put this strategy into action. Considering its solid foundation, with the right implementation plan the department should set itself the stretch goal to become a leading applied geoscience department in Europe.

1.1 Research Strategy

The Department of Geoscience (formerly Department of Geoscience and Petroleum) is a relatively new unit resulting from a merger of two departments. This has led to a department that is large with 37 permanent academics and 11 adjunct academics compared to other applied geoscience departments; this is regarded as excellent because it allows the department to tackle complex geoscience issues with the necessary critical mass. Research groups within the department have been merged too, and some reorganisation appears to be still ongoing, especially with respect to geophysics research which are partly based in this department and partly in the Department of Electronic Systems.

While the self-assessment report is somewhat light on detail regarding the departmental strategy, providing only generic information and ambitions at a high level, the interview with the department management team brought much needed clarity in that the strategy development has been completed and was a comprehensive endeavour that involved the entire department. The strategy now provides an overarching framework based on which an implementation plan is being developed to put the strategy into action.

A key focus of the strategy is to emphasise interdisciplinary research and teaching across three themes – geoscience, georesources, and geoinfrastructure and move the department beyond its more traditional petroleum remit. This change also involves a rebranding of the department. Overall, this focus is timely and well-aligned with changes at similar departments across Europe, and aims to future-proof geoscience departments through close alignment with the UN Sustainable Development Goals.

The new research focus is also well-aligned with the applied and technical focus of NTNU, allowing the department to remain a key player in the Norwegian research landscape that is well-connected to Norwegian research institutions and industry, especially through partnership in research centres. The generational change that will take place at the department provides a major opportunity to strengthen the focus areas by making strategic decisions which skillset the newly recruited staff members should have. With the right implementation plan (which could include support from and advisory board and consultation from other departments that underwent similar changes), the department should be able to further grow its international reputation.

One area that needs to be addressed in the implementation plan is to ensure that the cross-disciplinary nature of the three research themes will be taken on board by the research groups on a day-to-day basis. These groups seem to operate more in isolation at present (and in some cases are separated into further sub-groups with little collaboration between them), so there may be the need to incentivise groups support these cross-cutting activities.

Another aspect that needs addressing is the role of hydrocarbon industry funding in a more broader geoscience landscape. The department acknowledged that they are still reliant on oil and gas industry funding, and graduates from the department are well-sought after by the oil and gas industry. Although the situation regarding collaboration with the oil and gas industry is different in Norway compared to other European countries, care should be taken that the valid efforts of repositioning the department and broadening its remit are not seen as a “green washing” effort.

Although the department has some international visibility and collaboration, considering its size and reputation, the participation, and leadership, in international research consortia (e.g., Horizon Europe funding) could be stronger. Likewise, although the department leads an industrial research centre and participates in RCN research centres such as the PoreLab SFI, it does not lead any other RCN centres which comes a bit as a surprise. The same applies to the department’s involvement in professional societies; little, if any, evidence is presented that the department participates in key committees or organises conferences. It appears that the department could be more proactive and use its size and reputation to provide leadership in shaping the applied geoscience research and teaching agenda across Europe. This shortcoming has been acknowledged by the department in the interview, and the new strategy envisions a more proactive approach to showing leadership at the national and international scale, for example by being the coordinator for future research consortia.

Recommendations to the administrative unit:

- It is critical that the development of the strategy implementation plan is prioritised and has some robust benchmarks and KPIs that allow the department to track progress. The department is a strong position to build on its foundation so that it can aspire to become a leading institution in applied geoscience in Europe. However, other departments are moving ahead so there is a risk of “missing the boat”. Working with an advisory board to stress-test the implementation plan and/or engaging with other European geoscience departments that underwent a similar change could prove to be very beneficial, not just in terms of receiving constructive feedback but also strengthening the department’s position within the faculty and university.

- Within this implementation plan, specific emphasis with respect to research should be put on how to incentivise the research groups to collaborate more closely with each other so that they support building up the three research themes (e.g., by using internal funds to pump-prime PhD projects) and jointly develop proposals that put the department into a position where it can lead Horizon Europe or RCN centre bids.

- Another key aspect in the implementation plan is to develop a sound succession plan. This plan needs to provide a convincing narrative about the strategic choices how the department will replace existing staff under the upcoming generational change. Otherwise, it is not inconceivable that the department may be asked to reduce staff numbers considering that university funding in Norway is declining, like anywhere else. A more proactive approach to highlighting past impact to industry and society could be helpful to underpin such a narrative.

1.2 Organisation of Research

Overall, the research organisation of the department appears to be commensurate to operate a department of that size. The department head is supported by deputy heads for research and teaching as well as an administrative team. Through these personnel, the department links into the relevant university and faculty committees and processes. Research is currently centred around individual research groups, and some management responsibilities are devolved to the research group heads. The strategy envisions that the

research groups will work more collaboratively and interdisciplinarily in the future, which is a very sensible approach to tackling new challenges in applied geosciences.

The self-assessment lacks details on processes for research, teaching, and day-to-day operations (e.g., regularity of department meetings, recruitment decisions, EDI, social safety, etc.) where the department seems to follow university processes by and large but does not take any further actions (e.g., EDI and social safety at geoscience departments are notoriously tricky during field trips and field works). The self-assessment also lacks quantitative information how the department benefits from university opportunities related to mobility, gender equality, etc. (e.g., how many Onsager Fellowships are applied for/won, how many students take advantage of mobility such as Erasmus+), although the interview revealed that the department has benefitted from these activities in the past and currently has two fellows among its staff.

Teaching activities at the department underwent a significant reorganisation, a process that must not be underestimated in terms of time and effort; it is not unconceivable that these efforts have impacted some of the research activities. Two new MSc programmes have been created as a result and old ones, focusing on petroleum study programmes, are being phased out. It is certainly very timely to bring more sustainability topics into geoscience teaching, and the interview revealed that the student numbers in the new study programmes are stable if not increasing, which reflects upon the quality of the programmes, the need for such training, and the attractiveness of the department.

PhD training is handled through the faculty and seems to be appropriate but could be stronger on issues related to social and psychological safety. For future assessments, it would be good to have feedback from PhD candidates and data on completion time and retention. Where the department stands out is that it provides internal funding for department-sponsored PhDs to ensure parity between PhD students; this is commendable because it is often a source of stress or even envy.

Early career researchers receive some support and training, but the department acknowledges that more needs to be done in terms of mentorship and coaching to support the long-term development of its staff.

Recommendations to the administrative unit:

- The department should be proactive in pursuing university-wide initiatives such as the Onsager fellowships to attract talented staff to the department that can fill strategic roles beyond what is included in a succession plan.
- The department should ensure that a tailored EDI plan and robust support system with respect to social and psychological safety is put in place. These plans/systems should consider the specific challenges inherent to geoscience departments and include MSc and PhD students as well. In addition, the mentoring and coaching for early career researchers should be formalised and expanded, for example by adapting the Delta programme from SINTEF Digital.
- The new study programmes need to ensure that research and teaching remain well-connected and material is updated as research themes grow. For example, there seems to be little teaching in critical raw materials, a key topic in applied geoscience. Likewise, the lack of research-led teaching has been partially criticised in some research groups.
- The department should use its reputation to develop some strategic international partnerships for teaching and research in geosciences and track how PhD students and MSc students benefit from international mobility as a result.

1.3 Research Funding

The funding portfolio is diverse, well-balanced, and competitive in terms of income numbers. On average, each permanent academic attracts around 2M NOK per year which is above-average with international benchmarks. Currently, around 50% of the total department budget is attributed to research funding. The majority of the funding comes from RCN with relatively little from EU sources, which as noted above is surprising. The department is involved in a small number of contract-research projects, which seems appropriate in size and effort to maintain industry connections while not distracting from the lower TRL research that universities typically focus on. However, funding income has declined in recent years (even without accounting for inflation and increase in overheads). The department is aware of this trend and its strategy implementation plan aims to address this (see above and below).

Although the self-assessment does not provide any details, during the interview it became clear that funding varies between research groups and individuals with some being more successful, and more active, in pursuing research proposals than others. The department is aware that the strategy implementation plan will need to address: on the one hand, there is the risk that successful academics leave (e.g., for industry or another university) and funding in an area ceases; on the other hand, staff with a smaller research grant portfolio need to be incentivised and supported to grow their externally funded research activities. This is not an easy task, but the department has identified university-wide themes such as an energy cluster or the security of supply (with respect to critical raw materials) as attractive opportunities for both, successful academics and those who wish to grow their grant portfolio. Furthermore, if the department succeeds with its strategy to work across research groups on key themes, leads more Horizon Europe consortia and/or RCN centres, and supports early career researchers through a strong mentoring and coaching programme, there will be inevitably abundant opportunities to grow research income.

Recommendations to the administrative unit:

- The strategy implementation plan needs to ensure that the research funding portfolio continues to be diversified and takes advantage of funding opportunities related to georesources, geoscience, and geoinfrastructure. Such a diversification will naturally help the department to transition away from more traditional oil and gas research and hence helps to de-risk the aforementioned impression that any changes could be viewed as “green washing”. However, diversifying research funding will require not only a strong interdisciplinary approach but also a proactive mindset where the department identifies opportunities and uses its reach to lead consortia funded by the EU and RCN. Furthermore, a coaching and mentoring programme should support these activities to ensure that the staff base who can lead major initiatives continues to grow; the Delta programme at SINTEF Digital may be a good starting point based on which a mentor programme could be developed.

1.4 Research Infrastructures

A key strength of the department is its excellent research and laboratory infrastructure which is supported by permanent staff. Such an arrangements are increasingly rare because more and more geoscience departments require to fund support staff from grants, which puts entire laboratories at risk if there are prolonged gaps between grants. However, the self-assessment lacks clarity how maintenance and expansion of such excellent research infrastructure is assured, and how research infrastructure will support research strategy; this could be a potential risk to maintaining the infrastructure if university budgets come under (further) pressure.

The co-location with SINTEF provides further excellent opportunities to bridge across from lower TRL research to more applied research, but the self-assessment provides little information on how this co-location benefits the department in its day-to-day operations.

The department follows university procedures for FAIR principles regarding research data management, which is adequate.

Recommendations to the administrative unit:

- The strategy implementation plan needs to ensure that sound measures are put in place how to maintain and grow, or where appropriate decommission, research infrastructure.
- The opportunity to access to world-class research infrastructure should be used as a bargain chip to develop new international collaborations and lead major research consortia. This could be further enhanced by showcasing the department research infrastructure on its website and highlight the impact that this research infrastructure had in the past (e.g., via short videos or “stories of science”).

1.5 National and international collaboration

The department is a well-connected and well-respected research partner in Norway and maintains strong links to all relevant research institutions including industry. As noted above, the department tends to participate but rarely leads (with exception of one industry consortium) major national research consortia, which raises the question if its peers view the department as a trusted partner but not a leader in Norway.

The links to international research institutions are more limited and appear to be ad-hoc to some degree, i.e. project based, rather than based on a long-term strategy. While there are some notable collaborations such as with Brazilian institutions that emerged on the back of the pre-salt oil and gas discoveries and Equinor’s subsequent involvement in Brazil, the lack of more wide-ranging research collaborations with international partners is highlighted as an area for improvement across all research groups. It is somewhat surprising that the department does have below-average international collaborations considering the reputation and reach of NTNU.

Recommendations to the administrative unit:

- The strategy implementation plan needs to contain an approach that supports strategic, long-term research and teaching partnerships with international partners. As noted above, the NTNU “brand”, the focus on applied and timely topics in geoscience, the strong reputation of the department in the geoscience community, and the world-class infrastructure should make developing such strategic and long-term teaching and partnerships comparatively easy. For example, the department could consider using the IDEA league Masters in Applied Geophysics as a template to partner with other technical universities in Europe to create a joint study programme related to one of its focus themes or leverage Erasmus+ to create an opportunity to exchange MSc students and foster international collaborations.

1.6 Research staff

Recruitment at the department follows the university processes. The department has the aspiration to recruit good talent and improve gender balance. The processes and ambitions are commensurate with what is expected from a modern university. Considering that the department is undergoing a generational change, a strategic approach to recruitment succession planning is critical to ensure that the new focus areas for research and teaching

are able to grow, and that positions are protected in case university budgets come under pressure.

The department acknowledges that its gender balance is poor and adopting a good gender balance at the permanent academic level is challenging. It has benefitted in the past from university initiatives (e.g. fellowships) that aim to improve gender balance.

The department follows the 40-40-20 workload model that common in academia but no data is provided if this is upheld. A very positive aspect is that the university has a sabbatical model and funds are available to support sabbaticals. However, no information has been provided as to how many staff at the department take sabbaticals and how sabbaticals impact research (e.g., leading to new projects, collaborations, etc.)

What is surprising is the imbalance between PhD students and postdocs (41 + 4) versus permanent (37) and adjunct (18) staff. This ratio is below average as typically one would expect 2 PhD candidates (or postdocs) working on average with one academic inside Units aiming at international recognition. This imbalance should be addressed. If only the permanent staff are considered, the ratio becomes closer to the average of the other Units assessed in EVALMIT.

Recommendations to the administrative unit:

- As noted previously, the succession planning needs to be a key part of the strategy implementation plan. The department should consider linking the succession planning to a proactive approach to EDI – beyond what university is doing – and firmly embed EDI in the recruitment strategy. Not only will this help to attract talented researchers, any appointments that are made now will impact structural (im-)balanced regarding gender and diversity for years to come. Proactively pursuing opportunities to recruit new talent to the department via the Onsager Fellowships is also strongly recommended.

1.7 Open Science

The department and research groups follow the university policies and procedures regarding open science, which are appropriate and well-aligned with international practice. There is a clear upward trend in open access publication statistics, although due to embargos some published papers are still not yet available as open access via university servers. Some software developments at the departments are released as open source but could be promoted better.

Recommendations to the administrative unit:

- All groups in the department should continue to focus on open access publications, making use of university agreements with publishers and journals that support open access and promote open-source software development, as well as open access data, more proactively on the department website. The endeavour to increase open access and open science outputs also needs to address the issue that long embargos prevent academics from publishing papers as open access early on.

2. Research production, quality and integrity

All reports positively highlight the applied research nature of the research groups and that their research activities are very well aligned with the needs faced by industry and society in Norway – from energy production to protecting infrastructure to producing critical raw materials. The applied nature and relevance are also evident in the patents and spin-out companies that have emerged from the research at the department.

All research groups are well-respected and well-connected with the relevant research partners in Norway and industry, and participate in the key research centres. However, a weakness that was recognised across all groups is the lack of internationalisation and lack of leadership (e.g., leading research centres, EU consortia, or an active involvement in professional societies). The individual expert panels also highlighted that the groups lack a detailed research strategy. This particularly applies to the Engineering Geology and Rock Mechanics group. To some degree, this lack of detailed strategy at the group level can be explained by the fact that the department had to develop its overarching strategy first before implementing an action plan at the level of groups.

The publication quantity amounts to 105.4 author shares (2020-2022 average). The citation impact, in terms of the share of 10% most cited publications (5.4%) and mean normalised citation score 2019-2021 (74, mean=100) are quite low.

The research output of the individual groups was judged by the expert panels as mixed because in some instances the output focuses more on incremental research advances rather than showcasing fundamental scientific discoveries. There is room to disseminate the more fundamental research that underpins the applied results through agenda-setting papers in in some of the high-impact journals in the field.

The expert panels also noted the difference in external funding among the research groups, leading to some imbalance in terms of permanent staff vs. PhD students across the individual research groups. The Engineering Geology and Rock Mechanics group appears to be performing below the other groups in this regard. There is also a lack of clarity as to how balanced teaching and research activities are across groups. The department should ensure that it has the granular data available to understand these differences so that they can be addressed in the action plan when implementing the strategy.

Research groups that have a more traditionally focus on petroleum related research (geology, wells & reservoir, geophysics) are in the process of diversifying beyond oil and gas applications but perhaps at a slower pace than some other universities in Europe. The new research strategy and focus on three specific themes will certainly help this diversification but will, as noted above, require that the research groups are incentivised to collaborate more across their traditional boundaries.

The university has sound processes and policies in place to ensure research integrity and ethics are upheld, and the department adheres to these processes and policies.

2.1 Research quality and integrity

Research groups Engineering Geology and Rock Mechanics overall assessment

Strengths of the research group are, that the research topic is of high interest for coping with energy transition towards renewables and a safe built environment specifically when geohazards occur, that the professors are very strong with complementary expertise and research focus, that there are multiple collaborations established with partners having complementary skills and expertise as well as the group has access to an excellent infrastructure leading to combine lab and field measurements with numerical modelling. Specifically, the participation in the Gemini Centre Tunnel Technology 2.0 has the potential for strengthening research capacity and (international) visibility. The student numbers and teaching involvement is on a high level. Weaknesses are seen in a missing clear and cohesive strategy as well as mechanisms for strategic development as well as quantitative benchmarks. Furthermore, the level of international cooperation is limited and the number of

PhD candidates as well as external funding are assessed as rather low compared to the number of permanent staff.

Research group Mineral Production and HSE overall assessment

Strengths of the research group are that the group covers in Norway a unique, but of high societal importance, thematic research area and is embedded in and having access to a strong environment, specifically in terms of research infrastructure on departmental as well as university level enabling for the diversification of funding sources supporting future growth and development. Weaknesses and challenges are seen in the broadness of the research fields in combination with a lack of a recognisable specific organisation and strategy on research group level. The student numbers as well as external funding is rather low compared to research groups personnel resources. The research group is specifically strong in an international context in some research areas, specifically deep- sea mining, even though a (strategic) participation in international networks is not apparent. The research group generally has essential personal resources as well as equipment and infrastructure, which provides a good basis for future development and growth. The group has strong networks and collaborations, mainly at NTNU and in Norway. The group already has an international outreach; nevertheless, it is recommended to further internationalise these collaborations and networks in line with the strategic orientation.

Research group Well and Reservoir overall assessment

WR has high-quality researchers with the appropriate range of competences to address the group's key research priorities. The research group co-manages national research facilities (NorPALabs). WR attracts a reasonable amount of research income from the research council and industry. WR also supports the education of MSc and PhD students, although the number of MSc students has declined over the years as petroleum engineering/geoscience degrees have become less attractive. The self-assessment report does not contain a risk analysis to assess how a continued decline in students will impact the group's future plans.

The WR group participates in a wide range of important research projects, thanks to the group's very good collaborations within the Norwegian R&D landscape, specifically with research institutes such as SINTEF with whom they have shared laboratory facilities, the Norwegian oil and gas industry, and other universities within Norway. International collaborations are limited, focusing mainly on Brazil; the lack of international research collaboration was identified as a weakness by the Expert Panel because it reduces the international standing and visibility of the group.

The WR group is likely to meet its research goals, but the lack of both, a clear strategy and dedicated advisory board, makes reaching this task more difficult than needed and bears the risk that the goals are neither overly ambitious at an international level nor future proof considering the constantly changing university landscape. This is reflected in the self-assessment: although the WR group is clearly highly valued by its organisation and delivering good research, the Expert Panel found the self-assessment to be rather lacklustre and does likely not reflect what the group is achieving. Two specific aspects are as follows. First, while it is very likely that the WR group is conducting high-quality research, the Expert Panel cannot draw such a conclusion based on the presented research publications; these are of national importance rather than world-leading nature. Second, the group makes important societal contribution in terms of education and its work has led to several patents, with the work on plugging and abandonment (P&A) being particularly noteworthy as it will

make an important economic and benefits from close involvement with end-users. However, this is not well-documented in the self-assessment.

Overall, the Expert Panel judges the quality of research of the WR group as good but not outstanding compared to similar national and international environments.

Research group Geology overall assessment

The NTNU geology group was formed in 2017-2019 via the merger of two departments. While the merger provides an opportunity to better link the new group with the department's future research strategies (CO_2 storage, onshore and offshore mineral resources, geohazards/resilience studies, and infrastructure development), the group's current research builds on and develops knowledge linked to the tectonics of rifted margins, sedimentology and basin analysis, mineral characterisation/ore geology, and structural geology. Thus, it remains to be seen how successful this transition will be. The organisational environment is adequate for supporting excellent research. Much of the group's research quality is recognised internationally for originality, significance, and rigour, yet it falls short from uniformly attaining the highest standards of excellence. Societal impact is on par with that expected from similar groups in the subject and the group has considerable involvement in defining the research process. This is a strong group that should be aiming higher and it remains to be seen how successfully they will transition to green energy-related topics in research and development.

Research group Geophysics overall assessment

The group is well-organised and successfully supports a large number of early career researchers. Despite the stated strategy to transition from petroleum with some early signs of success, their vision for the future seems vague and greater support is required from the department and faculty to enable them to make an effective transition. The group produces internationally recognised research but does not provide the intellectual leadership needed to be classed as excellent or outstanding. A stronger articulation of their societal and economic impact could help the group attract both students and external funding.

3. Diversity and equality

NTNU has a sound diversity plan that is aligned with what a modern university should aim to achieve. However, the implementation at the departmental level unclear. The department recognises its poor gender balance as a shortcoming, which according to NIFU data has not changed much over the last 10 years. The department should be more proactive in pursuing EDI issues, as well as social safety. An important first step is that the department is led by a female academic. There are also other low-hanging fruits to showcase the work of female researchers at the department, for example by developing "stories of science" that feature a diverse group of researchers and are shared via the department website and social media. Perhaps most importantly, the generational change at the department provides a unique opportunity to change its profile especially if aligned with a strong and visible EDI profile.

Recommendations to the administrative unit:

- Developing a sound approach to EDI is a long process that needs outside help from experts. It also needs to be bespoke to the particular circumstances of a department. For example, field work and excursions need to ensure that they are as inclusive as possible (e.g., provide ways for students and researchers with limited mobility to participate, ensure that females are not disadvantaged when they have their period, etc.). Hence it can only be kickstarted as part of the department strategy. Nevertheless, the department

should clearly demonstrate its long-term and unequivocal commitment to EDI (internally and externally) and connect this to a sound approach to psychological and social safety.

4. Relevance to institutional and sectorial purposes

The department meets its mission to contribute to the teaching at NTNU through one BSc programme (Geology), two 2-year MSc programmes in Geology, and Geoscience and Georesources, respectively, as well as two 5-year integrated MSc programmes in Geotechnology and Petroleum Geoscience & Engineering, respectively. These study programmes are owned by the faculty and address the training needs of the Norwegian industry. The interview with the department revealed that student numbers are stable, if not growing, which is highly commendable as it is against the trend observed at most other geoscience departments.

Overall, the programmes are commensurate with what an applied geoscience department should be offering, although the continued teaching of a dedicated petroleum programme creates some contradiction with the departmental ambition to transition away from petroleum activities. Other departments have abandoned its traditional petroleum programmes in favour of broader subsurface energy programmes but it is noted that the Norwegian industry still requires dedicated training in petroleum geoscience and engineering.

Currently it is unclear how teaching related to mining and critical raw materials is included in MSc programmes and there is little discussion how new topics (e.g., machine learning) feature in the MSc programmes. There are clearly opportunities, see for example the recent successes at Imperial College London which has developed MSc programmes related to data science and subsurface energy.

Recommendations to the administrative unit:

- The department should continue to evaluate how new fields such as critical raw materials or data science/machine learning can be incorporated into its study programmes to ensure that the programmes remain relevant in a rapidly changing world. It may be necessary to expand some of the research activities first because some expert panels note a lack of research-led teaching capacity.
- The department should ensure that it understands what causes the strong student numbers so that it can continue to build upon these strengths and tailor its recruitment accordingly. This may require working on developing a robust narrative that explains how the continued education in petroleum geoscience and engineering aligns with the department's ambition to diversify its research portfolio and transition away from the more traditional petroleum activity. Otherwise, there is the risk that the valid efforts of the department can be viewed as "green washing".
- The department could also consider cooperation with other departments for joint teaching (e.g., environmental geoscience, geoscience and energy systems, machine learning applications, etc.) and explore opportunities to partner with other universities across Europe, for example to exchange students via Erasmus+ or even setup a joint study programme akin to the IDEA League Masters in Applied Geophysics.

5. Relevance to society

All research and teaching activities at the department are very relevant to Norwegian's society and industry, as highlighted by the expert panels throughout the individual group reports. Geosciences in the broadest sense are also key to supporting Norwegian's long-

term plan for research and teaching as well as the United Nations Sustainable Development Goals. To this end it is excellent that the department is aligning itself with both.

There is little doubt that the department has, and will continue to make, impact to the Norwegian society and industry. However, this impact could be documented more clearly and should also feature on the website and annual reports. In some areas, such as the important work the wells and reservoir group do with respect to plugging and abandonment, the economic impact of the research seems to be very much underplayed. In other areas the impact case studies lack real, measurable impact for society and industry.
Recommendations to the administrative unit:

- The department should showcase its alignment with Norway's long-term plan and the United Nations Sustainable Development Goals more clearly in its internal and external communications as these underpin everything the department tries to achieve.
- When developing its action plan to implement the strategy, the department should formulate clear KPI that demonstrate how its research and teaching supports the long-term plan, respectively the Sustainable Development Goals.

5.1 Impact cases

Better Resource Utilisation in the 21st Century

This case describes the impact of, mainly, the BRU21 project, where impact has been measured in form of

- Formation of two spin-out companies
- Training of 24 PhD and postdocs
- Continuous professional development courses
- New collaboration with Brazil
- Preparation of a report for the Norwegian oil and gas industry

Only the spin-out companies provide tangible data for impact in the form of employee numbers, annual turnover, uptake by industry and can be considered as a real impact for society. The other measures for impact are good, but lack quantitative data to show that they change industry practice or policy. Instead, these measures – new collaborations, PhD training, industry reports, CPD courses – should be expected from a long-standing, large-scale research project.

Unlocking the Deep-Sea Mining potential in Norway

This case describes the impact arising from deep sea mining research at the department (which trained 24 PhD students over the last 10 years) including

- Defining the resource potential in the NCS
- Establishing a deep-sea mining pilot
- Winning follow-up research projects including being partner in EU projects
- Delivering a summer school with ~50 attendees
- Establishing the Norwegian Forum for Marine Minerals

While these are potentially strong measures for impact, it is unclear how much these examples are real impact for society in that they changed policy and/or business practice. At least to some degree these measures are to be expected after 10+ years research involving

20+ PhD students. It is not unlikely that policy and business practices have been changed, but the evidence is too anecdotal and does not provide quantitative data, e.g. how the new Forum for Marine Minerals influences government policy.

Contribution for Capacity Building in Tunnelling and Hydropower in Nepal

This case describes the capacity building activities in Nepal, which feature

- 120 MSc graduates in hydropower development
- 38 MSc graduates in rock and tunnel engineering
- 6 PhD graduates

Capacity building in developing nations is extremely important and impactful, especially as – if claimed – 95% of the graduates are working in Nepal and influencing industry and government alike; a particular strong point in this regard is the provision of dedicated scholarships for women.

It is less clear how research itself (e.g., publications) has impacted the capacity building, i.e. if research results are now changing practices in Nepal or if the training of high-quality people has been more impactful; it appears to be the latter, although this is not to take anything away in terms of impact

This impact case would have been stronger and even more convincing if more quantitative data would have been provided; much of the evidence appears to be anecdotal, often citing “IGP-NTNU experience” that this capacity building contributed to the societal and economic development of the country.

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 HEI’s)

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 three 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 that the Administrative Unit self-assessment report was insufficient to assess all evaluation criteria fully. However, the interview with the Administrative Unit filled gaps in the Committee's understanding, and the information was sufficient to complete the evaluation.

List of administrative unit's research groups

Institution	Administrative Unit	Research Groups
Norwegian University of Science and Technology (NTNU)	Department of Geoscience	Engineering Geology and Rock Mechanics
		Geology*
		Mineral Production and HSE
		Geophysics*
		Well and Reservoir (originally registered as Subsurface Technology)

**: Research group have been evaluated in Evaluation of natural sciences (EVALNAT 2022-2024)*

Terms of Reference (ToR) for the administrative unit

The board of the Faculty of Engineering, Norwegian University of Science and Technology (NTNU) mandates the evaluation committee appointed by the Research Council of Norway (RCN) to assess the Department of Geoscience and Petroleum (IGP) based on the following Terms of Reference.

Assessment

You are asked to assess the organisation, quality and diversity of research conducted by IGP 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 5 aspects in your assessment:

1. As a department under NTNU's Faculty of Engineering, IGP follows common strategic goals and priorities from both a faculty level and centrally at NTNU, as well as on a departmental level. Relevant strategic documentation from NTNU has been listed under "Documentation". Note that the Faculty of Engineering's Research Strategy for 2018-2022 is still valid.

2. IGP is responsible for 5 research groups, whereas 2 operate mainly within natural sciences, and 3 operate mainly within mathematics, ICT and technology.

3. IGP is a relatively new administrative unit, and was established in 2017, after the merger of two former departments at NTNU (formerly known as the Dept. of Petroleum Engineering and Applied Geophysics and the Dept. of Geology and Mineral Resources Engineering). Physical co-localization of the department was implemented in 2018 and finalized in 2019. IGP has undergone substantial upgrades in research infrastructure post-merger.

4. Focus on research and education within the applied geosciences is currently undergoing comprehensive changes to better address new challenges, as well as changing societal framework conditions, relating to issues on e.g. climate change, energy transition, supply of raw materials, and increased demands on civil- and emergency preparedness. IGP is addressing these issues in its new Strategy Plan, to be finalized Q4, 2023.

5. IGP has addressed concern to the RCN regarding the lack of representative panels for two of the department's three areas of research covered by EVALMIT, and how this can negatively impact the planned evaluation of our research groups (with reference to the RCN document Vedlegg 3 Tentativ panelinndeling EVALMIT 2023-2024). We ask you to take this shortcoming into consideration.

a. Our concern was specifically related to IGP's Research Groups for Mineral Production and HSE and Engineering Geology and Rock Mechanics, as no planned panel for EVALMIT, nor the previous EVALNAT, has adequately covered these groups' research profiles.

b. NTNU IGP therefore requested that a new panel within Tekniske geofag be established, including the following keywords (in Norwegian): Mineralutvinning; Ingeniørgeologi; Hydro- og miljøgeologi; Bergmekanikk; Gruvedrift; Oppredning; Mineralforsyning; Geofarer. As an alternative, NTNU IGP requested that these keywords, including that of Tekniske geofag, were to be incorporated into an existing panel structure, tentatively the proposed Panel 10 from the above-mentioned appendix.

In addition, we would like your report to provide a qualitative assessment of IGP 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
- strategic plans of relevance from NTNU and its Faculty of Engineering, (hyperlinks to NTNU-sites included):
    - NTNUs main strategy 2018-2025 (e)
    - NTNUs development agreement with the ministry 2023-2025 (n)
    - NTNUs wider contribution to innovation, (n)
    - NTNUs international development plan 2023-2025 (e)
    - NTNUs development plan for open science 2023-2025 (e)
    - NTNUs development plan for gender equality and diversity 2023-2025 (e)
    - Faculty of engineering main strategy 2018-2025 (n)
    - Faculty of engineering research strategy 2018-2022 (e)

Interviews with representatives from the evaluated units

Interviews with the IGP 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 IGP 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 IGP and the RCN. IGP 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 Faculty of Engineering, NTNU and the RCN no later than two weeks after all feedback on inaccuracies has been received from IGP.

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)

The Research Council of Norway

Norges forskningsråd
Besøksadresse: Drammensveien 288
Postboks 564
1327 Lysaker

Telefon: 22 03 70 00

post@forskningsradet.no
www.forskningsradet.no

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