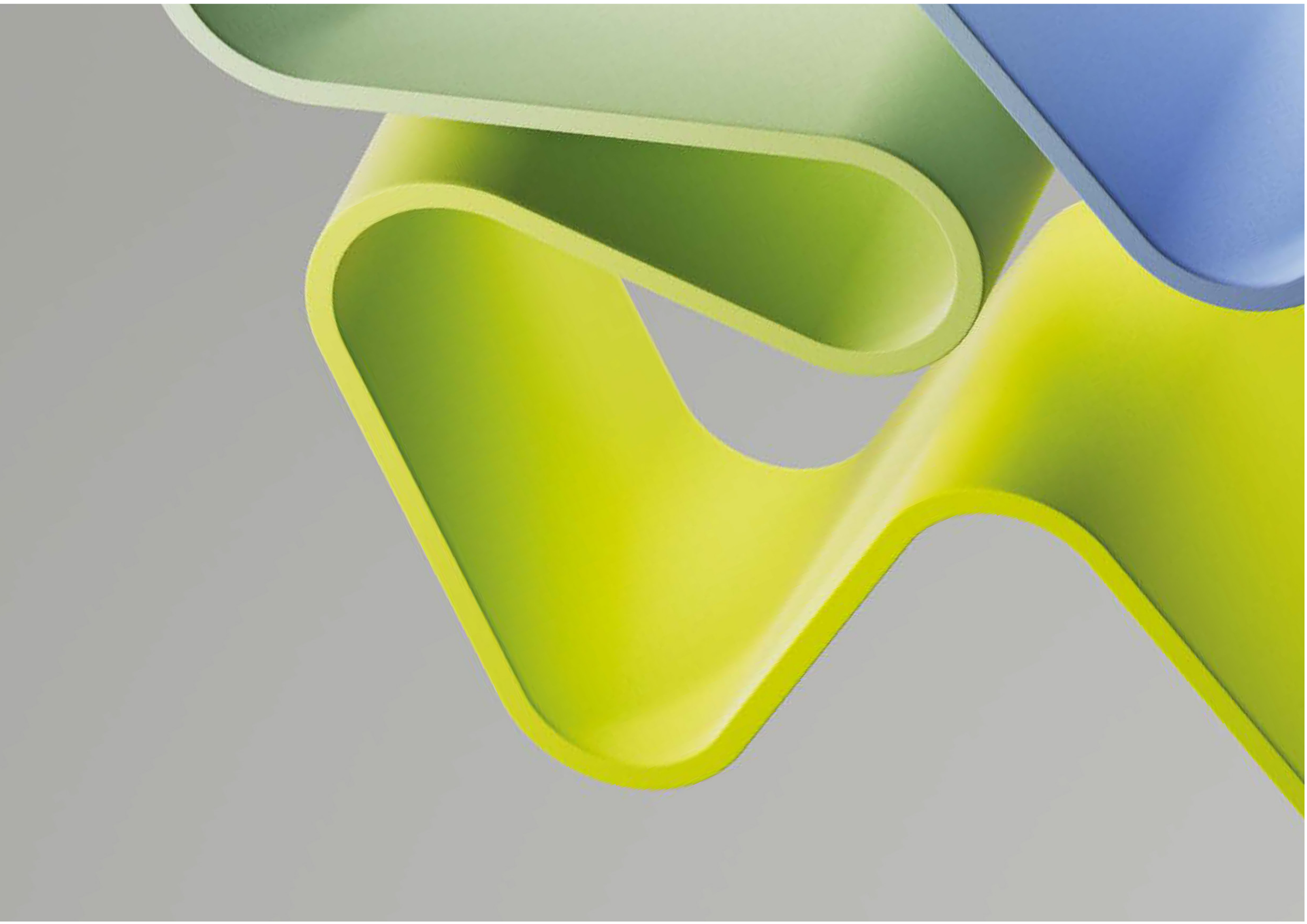
The Research Council of Norway

National report

Evaluation of Mathematics, ICT and Technology in Norway 2023-2024

March 2025



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Preface by the Research Council of Norway

The Research Council of Norway (RCN) has been commissioned by the Ministry of Education and Research to perform subject-specific evaluations of all scientific disciplines every ten years. In the period 2022-2025 two evaluations have been carried out: one in natural sciences (EVALNAT) and one in mathematics, ICT and technology (EVALMIT).

The primary aim of the evaluations is to identify and confirm the quality and the relevance of research performed at Norwegian Higher Education Institutions (HEIs) and across the Research Institute Sector. The reports offer an overall assessment of the state of the research in the ten-year period 2012-2022 as well as providing recommendations for future development of the research disciplines.

The evaluations were carried out by international peers with reference to an evaluation protocol describing the evaluation process and the assessment criteria (Appendix 3). The national report for the evaluation of Norwegian research in Natural Sciences 2022 – 2024 was published in March 2024 (https://www.forskningsradet.no/siteassets/publikasjoner/2024/evalnat/justert-evalnat-national-report-final-march-2025.pdf).

Each evaluation has been done at three levels; research groups, administrative units and national level. In the evaluation of Mathematics, ICT and Technology, 248 research groups were evaluated by 15 expert panels divided by subjects and disciplines within the research fields across sectors. Thereafter, five evaluation committees were established to evaluate the 56 participating administrative units (faculty/institute/department/centre). The assessments and recommendations from the evaluation committees are compiled in 56 reports. These reports give important input to the individual administrative units. Each administrative unit has a responsibility to follow up on the recommendations provided in their evaluation unit report. Seven international experts including the chairs of the five evaluation committees constitute the National Evaluation Committee which was requested to compile a report based on the assessments and recommendations from the 56 independent evaluation unit reports. The national report will be used by the Research Council in developing national funding schemes in dialogue with the ministries and the evaluated institutions/units

The national reports pay specific attention to:

- Strengths and weaknesses of the research area in the international context
- The general resource situation regarding funding, personnel, and infrastructure
- Ph.D. training, recruitment, mobility, and diversity
- Research cooperation nationally and internationally
- Societal impact and the role of research in society, including Open Science

Oslo March 2025

Composition of the National Committee for evaluation of Mathematics, ICT and Technology research

This report offers an overall assessment of the state of mathematics, ICT and technology research in Norway and presents recommendations for future development of the research disciplines. All committee members support the conclusions and recommendations in the report.

Professor **Krikor B Ozanyan** (chair)
University of Manchester

Professor **Deborah Greaves**
University of Plymouth

Professor **Claudio Mazzotti**
University of Bologna

Professor **Jan S Hesthaven**
Karlsruhe Institute of Technology

Professor **PM Sarro**
Delft University of Technology

Professor **Rebecka Jörnsten**
University of Gothenburg

Professor **Bo Wahlberg**
KTH Royal Institute of Technology, Sweden

Dr **Erik Arnold**, Senior Partner, Technopolis Group, was the secretary to the committee.

Summary

This report, authored by an international committee of scientific experts, reports the national-level results of the 2023-25 evaluation of Mathematics, ICT and Technology (engineering) research in Norway (EVALMIT) and makes recommendations for its future development. It builds on 15 panel evaluations of 248 research groups, which in turn contributed to 56 evaluations in administrative units such as university departments and research institutes. EVALMIT is one of four large field evaluations carried out in Norway in 2023-2025. The other three covered Natural Sciences (EVALNAT), Life Sciences (EVALBIOVIT) and Medicine and Health (EVALMEDHELSE).

The MIT fields (Mathematics, ICT and Technology) receive the biggest part of Norwegian state investment in research. RCN invested just under NOK 4bn in the fields of Mathematics, ICT and Technology (MIT) in 2022. Norwegian industrial R&D focuses in 5 branches – computing and electronics, machine-building, the petroleum, coal and chemical industries, metal products, food and drink. The first three branches are significantly dependent on the predominantly applied research in scope to EVALMIT. The research is needed not only to support Norway's competitiveness, but also the green and digital transitions and to maintain important scientific and industrial capabilities and security in an increasingly fraught global context.

The MIT fields are very broad. Norwegian research is solid overall, and tends to be specialised in nationally-important niches, where there is strong interaction with industry and where the quality of the research is generally high. In Mathematics, the older universities tend to have the strongest pure mathematics and statistics research groups, while institutes are more important in driving societal impact in applied mathematics. ICT comprises many sub-fields, with SINTEF and NTNU often taking leading roles in research, but there are also strong groups in the colleges and newer universities. The traditional universities tend to focus more on natural sciences than technology, but nonetheless have some strong ICT groups. 'Technology' covers a range of sub-fields at least as broad as ICT, but its specialisations are more clearly defined by their high relevance to longer-standing branches of industry, notably marine, energy, oil and construction. As in ICT, the development of this newer industry has provided more opportunities for newer colleges and universities. The combination of strong research and close industrial contact that is co-produced, for example, by NTNU and SINTEF is powerful in many parts of MIT.

Successful research groups tend to be larger than less successful ones, do high-quality applied research, have close interaction with industry and focus their research on identified industrial needs. They are members of international networks, especially through participation in the EU Framework Programme. Successful approaches are often interdisciplinary.

There is a good level of external funding across MIT, primarily from RCN. The EU Framework Programme is the second-biggest source, and enhancing this would both make funding more sustainable and help more Norwegian research groups to enter international networks, learn, develop and grow.

While the applied industrial focus of MIT research is key to societal impact, it needs to build on a greater amount of fundamental research to maintain competence and the capacity to innovate. The mathematical sciences provide one of the intellectual cornerstones for all three MIT fields and need to be part of this fundamental research effort.

A generation of senior researchers is approaching retirement age, presenting an opportunity to evolve research agendas in response to new needs and reduce the risks of lock-in to the needs of an established industry structure. Seizing this opportunity requires increased capacity to design and deploy strategies at research-group level that address change and renewal. More new blood is needed also among early- and mid-career researchers to increase research and PhD production.

The amount and quality of research infrastructure available to Norwegian MIT researchers is very good, providing a sound basis not only for implementing current research ambitions but also being attractive partners in international collaborative research.

Gender inequality is slowly reducing. The implications of ethnic and cultural diversity in a research community with a strong and increasing proportion of people with non-Norwegian origins requires more exploration.

A short summary of the committee recommendations:

- Increase the ability of Norwegian MIT research to react to and initiate change in a timely way, in response to changes in technology and needs; create new research capacity at significant scale where needed, for example in catching up in the field of AI
- Safeguard the foundations of MIT by increasing support to fundamental research, especially in Mathematics, without reducing the effort in applied work
- Review national aims with respect to increasing the research-intensiveness of newer parts of the higher education system, and establish mechanisms such as ‘pairings’ between new and established institutions and research groups to strengthen capacity
- Continue and strengthen the policy aim to increase participation in the EU Framework Programme
- Review the effectiveness of policies to reduce gender inequality in research to date and reduce gender inequality through career support to female researchers; investigate the policy implications of increasing recruitment into the research community from abroad

Sammendrag

Denne rapporten, som er utarbeidet av en internasjonal komité av vitenskapelige eksperter, gir en evaluering av matematikk, IKT og teknologi (ingeniør) forskning i Norge (EVALMIT) på nasjonalt nivå og gir anbefalinger for fagenes fremtidige utvikling. Den bygger på 15 panelevalueringer av 248 forskningsgrupper, som igjen bidro til 56 evalueringer av administrative enheter ved universiteter, høyskoler og forskningsinstitutter. EVALMIT er en av fire store fagvalueringer utført i Norge i 2023-2025. De tre andre dekket Naturvitenskap (EVALNAT), Biovitenskap (EVALBIOVIT) og Medisin og helse (EVALMEDHELSE)

MIT-feltet (matematikk, IKT og teknologi) mottar den største delen av norske statlige investeringer i forskning. Forskningsrådet investerte i underkant av 4 milliarder kroner i fagene matematikk, IKT og teknologi (MIT) i 2022. Norsk industris FoU fokuserer på 5 grener – databehandling og elektronikk, maskinbygging, petroleums-, kull- og kjemisk industri, metallprodukter, mat og drikke. De tre første grenene er betydelig avhengig av den overveiende anvendte forskningen i omfang til EVALMIT. Forskningen trengs ikke bare for å støtte Norges konkurranseevne, men også for de grønne og digitale omstillingene, og for å opprettholde viktige vitenskapelige og industrielle muligheter og bidra til sikkerhet i en stadig mer belastet global kontekst.

MIT-feltene er veldig brede. Norsk forskning er samlet sett solid, og har en tendens til å være spesialisert i nasjonalt viktige områder der det er et sterkt samspill med industrien og hvor kvaliteten på forskningen generelt er høy. I matematikk har de eldre universitetene en tendens til å ha de sterkeste forskningsgruppene innenfor ren matematikk og statistikk, mens institutter er viktigere for å drive samfunnspåvirkning innenfor anvendt matematikk. IKT omfatter mange delfelt, hvor SINTEF og NTNU ofte har ledende roller innenfor forskning, men det er også sterke grupper på høyskolene og nyere universiteter. De tradisjonelle universitetene har en tendens til å fokusere mer på naturvitenskap enn teknologi, men har likevel noen sterke IKT-grupper. "Teknologi" dekker en rekke underområder som er minst like brede som IKT, men spesialiseringene er tydeligere definert av deres høye relevans for langvarige industrigrener, spesielt marin, energi, olje og bygg. Som i IKT har utviklingen av denne nyere næringen gitt flere muligheter for nyere høyskoler og universiteter. Kombinasjonen av sterk forskning og nær industriell kontakt som er samprodusert av for eksempel NTNU og SINTEF er sterk i mange deler av MIT.

Vellykkede forskningsgrupper har en tendens til å være større enn mindre vellykkede, utfører høykvalitets anvendt forskning, har tett samspill med industrien og fokuserer sin forskning på identifiserte industrielle behov. De er medlemmer av internasjonale nettverk, spesielt gjennom deltakelse i EUs rammeprogram. Vellykkede tilnærminger er ofte tverrfaglige.

Det er et godt nivå av ekstern finansiering på tvers av MIT, primært fra Forskningsrådet. EUs rammeprogram er den nest største kilden, og å styrke dette vil både gjøre finansieringen mer bærekraftig og hjelpe flere norske forskningsmiljøer til å gå inn i internasjonale nettverk, lære, utvikle seg og vokse.

Mens det anvendte industrielle fokuset til MIT-forskning er nøkkelen til samfunnspåvirkning, må det bygge på en større mengde grunnleggende forskning for å opprettholde kompetanse og kapasitet til innovasjon. De matematiske vitenskapene er en av de intellektuelle hjørnesteinene for alle tre MIT-feltene og må være en del av denne grunnleggende forskningsinnsatsen.

En generasjon seniorforskere nærmer seg pensjonsalder, og gir en mulighet til å utvikle forskningsagendaer som svar på nye behov og redusere risikoen for å låse seg inn til behovene til en etablert industristruktur. Å gripe denne muligheten krever økt kapasitet til å utforme og implementere strategier på forskningsgruppenivå som adresserer endring og fornyelse. Det er viktig med god rekruttering også blant forskere tidlig og midt i karrieren for å øke forskning og doktorgradsproduksjon.

Mengden og kvaliteten på forskningsinfrastruktur som er tilgjengelig for norske MIT-forskere er meget god, og gir et godt grunnlag ikke bare for å implementere dagens forskningsambisjoner, men også være attraktive partnere i internasjonalt forskningssamarbeid.

Ulikheten mellom kjønnene reduseres sakte. Implikasjonene av etnisk og kulturelt mangfold et forskningsmiljø med en sterk og økende andel personer som ikke har norsk opprinnelse vil kreve mer utforskning.

En kort oppsummering av komiteens anbefalinger:

- Øk norsk MIT-forsknings evne til å reagere på og sette i gang endringer i tide, som svar på endringer i teknologi og behov; skap ny forskningskapasitet i betydelig skala der det trengs, for eksempel når det gjelder å ta igjen AI-feltet
- Ivareta grunnlaget for MIT ved å øke støtten til grunnleggende forskning, spesielt innenfor matematikk, uten å redusere innsatsen i anvendt arbeid
- Gjennomgå nasjonale mål med hensyn til å øke forskningsintensiteten i nyere deler av høyere utdanningssystemet, og etabler mekanismer som kobler sammen nye og etablerte institusjoner og forskningsgrupper for å styrke kapasiteten
- Viderefør og styrk det politiske målet om å øke deltakelsen i EUs rammeprogram
- Gjennomgå effekten av policyer for å redusere kjønnsulikhet i forskning til dags dato og reduser kjønnsulikhet gjennom karrierestøtte til kvinnelige forskere; undersøk policy-konsekvensene av å øke rekrutteringen til forskningsmiljøet fra utlandet

Det er det engelske sammendraget som er det gjeldende.

1. Norwegian research in Mathematics, ICT and Technology in context

Introduction

This evaluation of Norwegian research (EVALMIT) covers Mathematics, Information Technology (ICT) and Technology (engineering). It is one of four large field evaluations carried out in Norway in 2023-2025. The other three evaluations covered Natural Sciences (EVALNAT), Life Sciences (EVALBIOVIT) and medicine and Health (EVALMEDHELSE). All four form part of RCN's rolling programme of field evaluations, which are normally conducted at approximately ten-year intervals.

As with the other field evaluations, participation in EVALMIT was voluntary, but most research organisations active in the field asked that their relevant research groups and administrative units (AUs) should be included. In total, 248 research groups[1] from 56 administrative units (faculties, institutes or departments) participated (see Appendix 5), involving about 5,580 researchers – some 3,700 from the higher education sector and about 1,900 from research institutes.

EVALMIT has been carried out entirely by scientific peer reviewers. The research groups were evaluated by expert panels, based on their self-assessments. The administrative units were evaluated by expert committees, informed primarily by self-assessment reports from the units but supplemented by video interviews with several representatives of each unit. This national report has been prepared by an expert committee, comprising chairs and other members of the committees that had evaluated the administrative units on the basis of the research group and administrative unit reports. Supporting information, statistical data and bibliometric indicators have also been made available to the panels and committees as important context for EVALMIT. These quantitative metrics were largely consistent with the committees' qualitative judgments derived from the informed peer review process. The assessments made here are the responsibility of the national evaluation committee, whose members are described in Appendix 6.

This introductory chapter describes the context within which mathematics, IT and technology (referred to in this report as 'MIT') research is done in Norway. It discusses policy, the development of the economy and the research sector in Norway before summarising previous evaluations of the same fields in Norway done about a decade ago.

Norwegian policy context

Like other countries in NW Europe, Norway has seen a multiplication of higher education institutions (HEIs) in recent decades. Despite a number of state-promoted mergers (the 'structure reform' of 2016), in 2024, the public HEI system still comprised 11 public universities and 15 state colleges (*høyskoler*). The government has decided to maintain the concentration of research capacity in the larger traditional universities, arguing that this is necessary to avoid fragmentation and maintain excellence. While successive governments have increased institutional funding[2] to the smaller and newer organisations in the last five years or so, there are still big variations in the proportion of institutional funding provided to different organisations. HEIs are free themselves to decide how to use their institutional funding (which is not formally divided by the government among education, research and knowledge exchange). Correspondingly, the proportion of academics' time allocated to research as opposed to other activities varies among HEIs.

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[1] In order to make best use of panel members' expertise, one research group was evaluated by an EVALMEDHELSE panel and 17 by EVALNAT panels.
[2] Institutional (or 'core' or 'basic' or 'block grant') funding is the money paid to the university or institute to cover its normal running costs. Traditionally, this has been a 'lump sum' and the university has itself decided how to spend it. Increasingly, however, it is earmarked to specific purposes. This is distinct from 'external' funding, which is normally intended to be spent on specific projects or tasks.

HEI policy is periodically updated in 'long-term plans'[3] announcing the government's priorities. The most recent plan for 2023–2032 has overall objectives of enhancing competitiveness and innovation capacity, environmental, social and economic sustainability, high quality and accessibility in research and higher education, and the following thematic priorities:

- Oceans and coastal areas
- Health
- Climate, the environment and energy
- Enabling and industrial technologies
- Societal security and civil preparedness
- Trust and community

Norway is strongly affected by the geopolitical changes of recent years. Its position as NATO's North-East flank during the Cold War influenced both higher education and development policies, and, following the accession of Sweden and Finland, Norway is planning to scale up the defence sector[4].

Norway's position as an Associated State of the EU means that its concerns and policies are mostly aligned with those of the Union. The EU's list of 10 'critical technologies' – many of them in MIT fields – is highly relevant also to Norway[5]. The recent communication from the European Commission[6] on competitiveness summarises its view on Europe's relative position, arguing that Europe is losing the productivity race internationally, and losing the technology race with the USA and especially China. The EU needs large-scale investment to modernise the economy while also rearming to meet new geopolitical challenges and still facing the wider societal challenges identified in recent years. The agenda of the Draghi Report (Draghi, 2024) sets three priorities:

- Closing the innovation gap
- Establishing a joint roadmap for decarbonising and competitiveness
- Reducing excessive dependencies and increasing security, in particular by
  - Catching up in AI
  - Digitalisation and diffusion of advanced technologies to increase productivity
  - Decarbonisation and competitiveness through energy innovation
  - Reducing dependencies to increase security

The EU's research and innovation priorities generally tend to be important for Norway. Because of its industrial structure, the marine area that has more policy priority for Norway than the continent.

Development of the economy and the research sector research in Norway

Norway is a late-industrialising, resource-based country that 100 years ago was among the poorest in Europe and is today among the richest. The structure of the research and higher education sector has peculiarities that reflect this history.

The higher education sector is dominated by the University in Oslo (UiO – see list of institutional abbreviations overleaf), founded in 1811 when Norway was under Danish rule. Formally, the University in Bergen (UiB) founded in 1949 was the second university, but the national technical college (NTH) in Trondheim has dominated technological education in various forms since it was set up in 1910, and was merged with other local organisations in 1996 to form the Norwegian University of Science and Technology (NTNU). The national agricultural college set up in 1911 became the Norwegian University of Life Sciences in 2014. The University in Tromsø (UiT), the 'Arctic' university, opened in 1972 to provide higher education, and especially medical training, to support economic

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[3] The most recent is the Long-term plan for research and education 2023-2032, Meld St 5(2022-2023)

[4] Forsvarsdepartementet, Forsvarsløftet – for Norges trygghet. Langtidsplan for forsvarssektoren 2025-2036, updated 2024

[5] The EVALMIT Committee's views on Norway's strengths and weaknesses in these technologies have been communicated to RCN in a separate note

[6] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, A Competitiveness Compass for the EU, Brussels 29.1.2025 COM(2025) 30 final (Draghi, 2024)

development and combat depopulation in the High North. The so-called BOTT (Bergen, Oslo, Tromsø, Trondheim) universities, which are cooperating to build common digital platforms, are regarded as the ‘old’ universities. Oslo and Bergen are traditional broad-spectrum continental-style universities; Tromsø has continental-style governance but a much narrower range of disciplines; and NTNU is recognisable as a university of technology. (Forskningsrådet, 2023)

FFI	Norwegian Defence Research Establishment
HVL	Western Norway University of Applied Sciences
IFE	Institute for Energy Technology
Kristiania	Kristiania University College
NGI	Norwegian Geotechnical Institute
NHH	Norwegian School of Economics
NMBU	Norwegian University of Life Sciences
NR	Norwegian Computing Centre
NTNU	Norwegian University of Science and Technology
OsloMet	Oslo Metropolitan University
Østfold	Østfold University College
Simula	Simula Research Laboratory
UiA	University of Agder
UiB	University of Bergen
UiO	University of Oslo
UiS	University of Stavanger
UiT	University of Tromsø, The Arctic University of Norway
UNIS	University Centre in Svalbard
USN	University of South-Eastern Norway
TØI	Norwegian Institute of Transport Economics

Table 1 Institutional abbreviations used in this report

The last 30 years or so have seen rationalisation among the many regional colleges, some of which have been given university status. The so-called ‘Quality Reform’ in 2003/4 brought the binary system of colleges and universities together into a single higher education system with a single set of funding rules based on those of the university sector, but leaving the colleges and new universities with a legacy of teaching-style funding structures and a need to develop research skills and scale while competing with the universities for external research funding. The process of remaking the colleges as universities is not complete, leaving open the question whether completing it is either economically affordable or wise.

As a resource-based economy (forests, minerals, oil and gas, fish and the mechanical and process industries to exploit them), Norway’s knowledge needs have been for applied research and engineering more than for basic science. Thus, Norway set up a chain of technical research institutes owned by the NTNF science and technology council in 1946, but established a traditional (basic) research council (NAVF) only in 1949. The professors at NTH established SINTEF in 1950 as a research and technology organisation to provide an outlet for their research, supporting technological development and innovation in industry. It is now the dominant force in the Norwegian institute sector, especially in the parts of industry to which engineering and ICT are central. Unlike continental equivalents such as TNO, Fraunhofer and VTT, which tend to receive 30% or more of their research income as institutional funding, SINTEF and the other Norwegian RTOs such as NORCE get about 10%. Their economic basis is therefore very different from that of the universities, which explains their greater focus on contract research and lesser volume of academic publication.

While Norway in the 20th Century was following a conventional path of industrialisation by entering higher value-added branches (for example, diversifying from bulk into fine chemicals), this was rudely interrupted by the discovery and exploitation of oil and gas in the 1960s, in which NTH and SINTEF were key. Prudent management of the resulting revenues helped mitigate the classic resource curse where resource exploitation crowds out other industries and turns the terms of trade against them. Nonetheless, the rising value of the krone and a successful effort to master the technologies needed for oil and gas have kept Norway largely locked into resource exploitation. In the absence of a perceived crisis, the research and higher education system and the economy more generally have only recently begun to adapt to the needs and opportunities of the post-petroleum age.

Its history means that the Norwegian industrial structure is focused on low R&D-intensity branches, and even if comparisons between these branches in Norway and internationally tend to put Norway at the R&D-intensive end of the spectrum in each branch (OECD, 2008), the overall effect is that business' share of gross expenditure on R&D is small: 47% of the total in 2021, compared with 33% in higher education and 20% in the institute sector (Forskningsrådet, 2023).

This pattern represents a radical change during industrialisation. The higher education sector's share of national R&D investment has been growing since the 1940s, and overtook the share of the institute sector after 1997 (Arnold, et al., 2001). Correspondingly, the institute sector's real-terms R&D expenditure and employment have more or less flat-lined during the last decade, while the figures for the higher education sector have continued to grow (Aksnes & Fossum, 2023). This changing balance results partly from policies that favour higher education research over that of the institutes, partly from slow industrial dynamics with Norwegian industry lagging global patterns of restructuring and the institute sector remaining faithful to its traditional technologies, and partly from the growing importance of new industries more able to use knowledge produced in the higher education system.

Current state of research in Norway

Norway's gross **expenditure on R&D overall** was some NOK 81.6bn or 1.89% of GDP in 2021 – down from its all-time peak of 2.24% the previous year[7]. Business spent approximately NOK 38.3bn (47%) of this, the higher education sector NOK 26.9bn (33%) and the institutes NOK 16.4 (20%) (Forskningsrådet, 2023). The GERD figure of 1.89% of GDP is well below the Barcelona Goal of 3% to which the EU aspires, below the 2.15% level actually achieved by the EU in 2021, and the OECD average of 2.72%. This apparently poor showing partly reflects the 'inflation' of Norway's GDP by its large oil and gas revenues. In absolute terms, Norwegian gross spending on R&D per capita has been rising year on year for several decades.

The university sector accounts for 70% of research expenditure in the **higher education** sector (HERD). The regional health authorities account for a further 15% of HERD, with a large number of smaller universities and colleges for the remaining 15%. Within the university sector, research spending is very concentrated. NTNU alone expends 18% of HERD and UiO 17%. Together with UiB and UiT, the four established traditional universities alone account for over 50% of HERD.

Four of the five **research institutes** included in EVALMIT belong to the 'techno-industrial institute' group – one of four groups into which RCN places the research institutes when allocating their institutional finding. (These are research and technology organisations, or RTOs in international terminology). Institutional funding accounts for only 11% of this institute group's income, or a quarter to a third of the proportion provided in continental RTO systems such as TNO, VTT or Fraunhofer. Research in the techno-industrial institute sector is even more concentrated than that in the universities. SINTEF is the dominant force. The techno-industrial institutes had a combined turnover of NOK 6,688m in 2023, of which SINTEF accounted for 59%, IFE 17%, NORCE 8% and NR 2%. The other institute evaluated in EVALMIT is Simula, whose institutional funding is provided by the Ministry of Education and Research directly, rather than via RCN. Its NOK 296m income in 2023 corresponds to about 4% of the combined income of the techno-industrial institutes.

Industrial R&D is focused in 5 branches – computing and electronics, machine-building, the petroleum, coal and chemical industries, metal products, food and drink – together spending in excess of NOK 8bn on R&D in-house. The first three branches are significantly dependent on research in scope to EVALMIT. Business expenditure on R&D in ICT has risen over 80% in real terms between 2011 and 2021, while real expenditure in other areas of technology has been more or less flat during the period.

[7] OECD, Main Science and Technology Indicators

Using GDP to normalise R&D statistics gives a false impression of Norway's research because the GDP denominator is 'inflated' by Norway's big oil & gas sector. The OECD's Main Science and Technology Indicators for 2021 show that Norway has the ninth-highest number of researchers per 1000 of population, with 18.4, well above the OECD as a whole (15.1) and the EU (14.7). Only Austria, Belgium, S Korea, Taiwan and the other Nordic countries are ahead of Norway on this dimension. In terms of 2022 publications in the Web of Science per inhabitant, Norway ranks third in the World, with 3.18 per 1,000 inhabitants after Switzerland (3.47) and Denmark (3.35). this compares with 2.09 in the UK, 1.47 in the USA and 0.55 in China (Forskningsrådet, 2021; Forskningsrådet, 2023).

Analysis of Norwegian publishing in the Web of Science suggests that, compared with the global average, Norway has a relative specialisation in the social sciences, health, biology, and geoscience. It is specialised away from materials science, physics and chemistry, while its specialisation in mathematics and the information sciences is only a little below the global average (Forskningsrådet, 2021).

Norwegian research is well cited. High rates of citation are normally taken to indicate high scientific quality. Different research communities are of different sizes and have different publishing and citation traditions, so it is rarely meaningful directly to compare numbers of citations across disciplines. Comparisons can, however, be made using mean normalised citation scores (MNCS), calculating where individual articles sit on the distribution of citations in their specific discipline and normalising this around 100 (or sometime 1), which represents the mean number of citations per article in the discipline. NIFU's calculations for all articles published in 2021-23 by authors with an institutional affiliation in Norway show a mean normalised citation score (MNCS) of 115 – so Norwegian publications in the period are 15% more frequently cited than the global average. The corresponding scores for the most highly performing countries – such as the UK, Switzerland and The Netherlands – are generally in the range 129-131. The scores for the USA and China are 116 and 111, respectively (Karlstrøm, et al., 2024:5)

Previous evaluations

Earlier evaluations of the fields covered by EVALMIT point to research that is strong and often very good, but – perhaps unsurprisingly, given the size of the country – rarely world-leading. The evaluations stress the fields' industrial importance, but tend to miss the point that while links with traditional engineering-based branches are strong and have traditionally been supported by RCN research and innovation programmes, neither ICT nor mathematics can easily be identified with specific branches or government ministries. As a result, there is less impetus to devise national strategies or funding programmes for them, and there is a risk of being reactive rather than leading in tackling new areas or fields.

In line with the structure of the economy, which is engineering- rather than science-based, Norway did better in the applied aspects of the three fields than in the fundamental or theoretical. In human resources, there were issues involving succession and the future supply of (especially native Norwegian) faculty. Mobility during the academic career was too low. Women were significantly under-represented.

Norwegian engineering and the national university of technology (NTH/NTNU) have consistently been criticised by international evaluation panels as being overly applied. The engineering sciences were last evaluated in 2015, in an evaluation that focused on basic and long-term research (Rauch, et al., 2015). The committee found that "engineering science in Norway is slightly above [world] average for scientific quality and clearly above average with respect to impact and relevance [but] there is a lack of groups conducting excellent research with little (current) practical use." Publications were generally in medium-level journals and conferences, supporting communication with practitioners, but there were few in high impact-factor journals orientated to basic research. Research strategies were seen as "relaxed", and research topics responded to opportunities and researchers' interests rather than to a scientific strategy.

Consistent with national needs, the areas with highest quality were marine technology and climate, and fossil fuel research, while almost all engineering research was closely linked to established industry and its needs. Petroleum research was fragmented, and good but not excellent. Materials science within engineering involved worthwhile work supporting existing industry, but was not keeping up with the latest developments at the forefront of materials science. Some new areas, such as 3D microprinting and laser processing, were not covered at all. The only group in the area of road and transport engineering was at NTNU and was rated as 'underperforming'.

More generally

- The gender balance was improving, but still poor
- Recruitment of PhD students and faculty were impeded by low wages in Norwegian academia compared with industry, leading to a large inflow of non-Norwegians
- International cooperation was patchy and person-led, rather than strategic
- Too little fundamental research was being done in engineering science
- While links to established industry were strong, TTO services and links to new companies were inadequate
- Research at colleges and the new universities was generally weak and its systemic role was unclear

ICT was last evaluated in 2012 (Hesthaven et al, 2012). The committee found that the quality of Norwegian ICT research was broadly good and higher than would be expected from a country of Norway's size. While it is impossible to excel in all areas, the work was often sufficiently good that – given more investment – it could be ranked among the best. (Unfortunately, the evaluation was not specific about which areas were strong and which were weak.) The gender balance in ICT was poor.

Demand for higher education in ICT was strong and growing, but this meant that university recruitment prioritised the needs of teaching, making it hard to devise and implement research strategy in the universities. Nor was there any national strategy for ICT research, so the lack of strategy at national and university levels limited the quality and impact of research, and this problem was exacerbated by the modest progress being made towards setting up larger research groups and centres that could bring Norwegian research to the forefront in selected parts of ICT. The lack of strategy often extended also to hiring and succession planning. Productivity was also impeded by a lack of postdocs. International mobility was impeded by the variable provision of sabbaticals. The community made too little use of European programme, which generate value for research and help train less experienced researchers,

Mathematics was evaluated in 2012 (Tillmann, 2012). The report pointed to Norway's long tradition of excellence in mathematics, which is celebrated inter alia in the Abel Prize, and the importance of mathematics to the high-tech and engineering industries in Norway, as elsewhere. However, while applied mathematics and statistics had become stronger, there were signs of decline in more fundamental and theoretical areas. The evaluation identified areas of strength in analysis, algebra and algebraic geometry, topology and geometry, mechanics and stochastics. Research on partial differential equations was seen as outstanding, and the report referred to the early and successful development of computational mathematics as a Norwegian success story. However, number theory, mathematical physics and probability were seen as particularly under-represented. While some groups were aware of the potential industrial importance of their work, others appeared to be unaware or disdainful of the benefits of closer links to society.

Many senior professors were approaching retirement age, and some research groups were likely to disappear once their core members retired. There were too few internal candidates to replace them and a lack of postdoc positions that created a gap in career progression opportunities. Levels of faculty mobility were too low. No progress was being made on correcting the acute gender imbalance in mathematics. There was no specific funding available from RCN for mathematics, creating a need for funding and capacity-building in the field, both to keep it viable within the academic community and to maintain the needed research support to industry and society.

2. Strengths and weakness of Norwegian Mathematics, ICT and Technology research in an international context

2.1. The evaluation committee's perspective

This section presents the committee's assessment of mathematics, IT and technology research across the whole of EVALMIT. It is based on a reading of the research group reports for each of the 15, supplemented with information from the administrative unit level as well as background statistical sources. This section provides the committee's reflections on Norwegian performance on MIT research as a whole, then discusses mathematics, ICT and technology in turn. It builds on a more granular analysis of sub-fields, which is presented in Appendix 1.

The Committee's perspective on MIT as a whole

The scope of the fields evaluated here – mathematics, ICT, and technology – is very broad. The industrial context means that Norwegian research in these fields is mostly very applied. Given their central role in supporting industry, NTNU and SINTEF loom very large in all three fields. There are many successful Norwegian research groups and organisations in these fields, doing research with high quality and relevance to the Norwegian context. However, not all the groups are this successful.

Pure mathematics has a long tradition in Norway, with the strongest groups being in the older universities, notably UiO, NTNU and to a lesser degree UiB. Mission-orientated organisations including SINTEF and Simula are more important and drive societal impact in applied mathematics, though UiO, NTNU and UiB also play important roles. In statistics, too, the leading research groups are at UiO, NTNU and UiB.

ICT research comprises many sub-fields and affects many different parts of industry, with SINTEF and NTNU often taking leading roles in research. Given its traditional focus on natural science more than technology, UiO does little research in ICT by comparison, but its informatics research is very strong. There are many strong research groups, some in the newer and smaller universities that have grown up in the last few decades during which ICT has built up to its current social and economic importance. These groups tend to be rather scattered about the ICT landscape since – while it is very important in the Norwegian economy – there is not a strong cluster of ICT companies in Norway whose influence would encourage the formation of academic clusters of related topics.

'Technology' covers a range of sub-fields at least as broad as ICT, but its specialisations are more clearly defined by their high relevance to longer-standing branches of industry, notably marine, energy, oil and construction. NTNU and SINTEF are the leading research performers in most parts of technology, though this is true to a lesser degree in oil technology. As in ICT, the development of this newer industry has provided more opportunities for newer colleges and universities.

<u>Success factors</u>

Differences in research group performance appear to be more driven by context and behaviour than by field or discipline. Successful groups are generally larger than unsuccessful ones; they have critical mass and benefit from spreading overheads across more people. The quality of their research is high, or at least adequate to their context. Unsurprisingly, since Norwegian MIT research is very applied, successful groups have close contacts with industry and other users of their knowledge in society. Hence, knowledge about needs helps shape their research agendas, focusing their efforts on providing solutions to problems that have a good probability of being adopted and therefore creating societal impact.

The successful groups have strategies based on a combination of this demand-side understanding and wider knowledge about advances in research and the technological frontier. Relevant demand may be situated at the regional level – it is not always necessary to connect to a national set of users. Strategies need to be formed at the research group level, where the understanding of the demand side is located. Departmental or organisational strategies tend to be too high-level to be effective, trying to span multiple research areas and societal needs, failing to be specific enough to be useful. Given the applied nature of Norwegian research in MIT, successful approaches are often interdisciplinary. Interdisciplinary work opens the door to new fields of research.

Good research is correlated with research groups' membership of international networks, bringing them into contact with global rather than only national research communities and developments. This requires a degree of short- as well as longer-term researcher mobility, and can often be supported by participating in the EU Framework Programmes. Contact with international research communities is crucial, because *de facto* research quality standards are set at the global level. Correspondingly, successful research groups have ambitious publication strategies, aiming to be visible in high-status journals and conferences, advertising their ideas and making it clear to the wider community that they would make promising research partners. The internal structure of research groups is also a key to success. There need to be enough junior researchers – especially PhD candidates – to 'leverage' the expertise of the professors, making the research efficient and making it easier to enter new and expanding research fields. Many of the more successful research groups have higher-than-average ratios of PhD candidates to professors.

Less successful research groups tend to lack these characteristics. There are individually successful groups in some of the newer and smaller colleges and universities, but in general groups that are struggling tend to be in such places (or in a few cases to have been brought into UiT or NTNU in recent mergers). They lack the scale advantages of the bigger groups. Their interactions with the demand side are often weak – sometimes because they have been unable to build networks; sometimes because they are in geographies where there are few or no local users for their knowledge. Less successful groups have vague strategies, rely on departmental or university strategies that in practice cannot guide action, or have no strategies at all. This in turn makes it hard for them to enter national and international research networks.

It can be hard for those in newer and smaller organisations to build internal organisations with the capacity to succeed. Those in colleges and newer universities have higher teaching loads than the established universities, so they lack the time needed to run and participate in successful research groups. They lack the 'pyramid' hierarchies needed for efficient research and often struggle to recruit and support PhD candidates, so their ratio of candidates to professors tend to stay low.

Some of the less successful groups are in the traditional universities. Their difficulties tend to be driven by a lack of interest in achieving societal impact, inability to develop strategy, lock-ins to established user groups with a reluctance to address new classes of problem (for example, retaining an oil focus while not preparing to tackle challenges posed by the energy transition). There were rare examples of research organisations' own governance and routines impeding change.

Common issues

A number of issues – both negative and positive – are common to more and less successful groups alike. One of the most obvious is the poor gender balance, from which the MIT disciplines suffer in most countries. While it seems to be neither worse nor better than in other countries, it is only slowly reducing. Student recruitment and retention (at both first-degree and PhD levels) is difficult, especially institutions outside the main cities.

The overall level of capacity to develop and deploy effective research strategies is variable, but inadequate in many places. The ability to change the content of research strategies is also limited by the established structure of Norwegian industry. Unless groups maintain strong international research networks, they risk being isolated from new fields and from current and future industries not well represented in Norway. Notwithstanding the involvement of some of the groups in the EU Framework Programme, greater participation in that and other international research networking arrangements is a need in almost all the groups evaluated in EVALMIT. Most researchers have opportunities to benefit from mobility support of various kinds, but these are under-prioritised compared with needs.

Some large changes in direction benefit from national strategies. The current, glaringly obvious example is AI, with leading countries investing in the billions in AI. The committee understands that Norway is also rolling out a capacity-building programme in AI. This comes a little late compared with elsewhere, and the intention to fragment the effort over six to eight centres undermines its likely effectiveness. The success-factors discussed above would suggest that a single centre would be more likely to bring critical mass in research. Wider efforts to build the capacity to **use** AI will also be needed, in both research and higher education.

Last but not least, while the committee recognises the inherently applied focus of the MIT fields in general and the particular importance of that applied focus in Norway to serve the needs of the economy and society, it believes the proportion of more fundamental research carried out in the Norwegian research sector is too small and that more funding for basic research is therefore needed. Fundamental research is important not only in its own right but because it builds capacity, connects the Norwegian research community with global advances and provides new knowledge on which future applied research and innovation can be built.

Mathematics

While bibliometric analysis points to a downward trend, overall, mathematics in Norway is doing well. Larger and older institutions produce high-impact research and maintain strong international networks and collaborate with industry and in interdisciplinary projects. Research groups that maintain a good balance between established areas of strength while also expanding in new emerging topics do well. Successful research environments maintain a high PhD-to-faculty ratio. In contrast, smaller research groups and groups at smaller or newer institutions struggle. Often, this can be linked to a lack of strong international or national collaborations, a static and narrow research agenda and/or a lack of cohesive research strategy and unclear research profile. The evaluation reports identify increased internal collaboration, focused research strategies and increased national collaboration (and ultimately international) as ways to mitigate the situation.

All groups expressed concern regarding the funding landscape or anticipated changes thereof. A drop in funding to fundamental research in mathematics can have rapid and long-term consequences for maintaining the competence needed nationally and risks spilling over to impact research quality in related fields. The decreasing trend in the number of students in mathematics further exacerbates this risk.

Many groups struggle with long-term recruitment strategies, especially recruiting female faculty but also retaining talent in academia after a masters or PhD, and preparing for generational turnover while also responding to new research trends and needs. Utilising mobility programs, working actively to foster junior researchers and career development are essential to meet this challenge. Smaller groups are especially vulnerable to staff turnover and need to establish long-term and focused research strategies.

Strengths	Weaknesses
• High-performing groups maintain active international research networks • Balancing traditional and emerging topics in research agenda • Strong and active interdisciplinary collaboration with academic, government and industry partners result in research with high societal impact • Dynamic research environments with a healthy balance between senior, junior faculty, PhDs and postdocs	• Underperforming groups tend to lack a cohesive research strategy and have limited internal collaboration • Groups lacking national/international networks and with unclear research profile have low visibility, lower productivity/impact • Gender imbalance • Several groups have an under-sized PhD programs which limits productivity, knowledge transfer and impact
Opportunities	**Threats**
• Active use of mobility grants, including MSCA and NRC, and internally funded research visits to expand international collaboration and funding. Link to long-term recruitment plans, fostering of junior faculty, and to address gender imbalance. • National initiative to increase the number of students in mathematics • Active collaboration with regional stakeholders to increase societal impact • Smaller groups should work strategically to identify areas of strength and develop a clear research profile. • Consider re-organisation of smaller groups, exploring synergies within and between groups to consolidate resources • Publication strategies that target high-visibility outlets, including conference venues for AI/ML	• Drop in student numbers • Drop in funding to fundamental research, lack of small/mid-size grants for career development • Fluctuating funding levels that lead to an over-establishment of topics that cannot be maintained long-term • Lack of long-term recruitment strategies in the face of generational turn-over, gender imbalance, lack of agile research agenda leads to drop in productivity/quality and impact • Static, narrow research agenda risks missing opportunities with global impact • Lack of clear benchmarking risks leading to poor strategic planning

Table 2 SWOT on Mathematics

ICT Overall

This section assesses research groups in ICT key areas, including virtual reality (VR) and human-computer interaction (HCI), control systems and robotics, software engineering, and AI and data science. Top performers, such as UiB's Visualisation group and UiO's Digital Signal Processing and Image Analysis group, excel due to strong collaborations, particularly with industry partners, which demonstrates significant societal impact and high-quality publications in top-tier conferences.

Norway has a strong tradition in ICT and software, and some strong research groups in parts of the rather disparate ICT field. Simula has particular strengths in cryptography, communications and software engineering. SINTEF is very strong in several fields including IoT, software, maritime ICT and several parts of AI. UiO is strong in DSP and visualisation, robotics and intelligent systems, reliable systems and AI-based digital innovation. NTNU has particular strength in control, robotics, autonomous systems, engineering cybernetics, software engineering, nanotechnology, photonics and DSP. Narrower points of strength were at NORCE in earth and space observation, and its E&T Measurement Science group. UiB has a particular strength in visualisation and UiA in IoT and mobile communications. By and large, the quality of the university research is higher than that of the institutes, which tend to have greater socio-economic impact than the universities, but as indicated there are also some fields where institute research is also excellent. In all cases, high-quality research is associated with close networking and cooperation with industry.

ICT publication output is dominated by NTNU and UiO, but some of the newer universities (together with UiB and UiT) are medium-sized contributors. The published output is mainly in electrical and electronic engineering and in computer science.

The mean normalised citation score for the whole of ICT averaged 118 over the last decade but was generally below this level in 2013-2017, and above it in subsequent years. MNCS for the various ICT sub-fields suggest Norway does better in applied and interdisciplinary research than in fundamental work.

There are, however, also weak points in both large and small organisations, Challenges faced by these research groups are multifaceted. Funding limitations, especially for fundamental research, are a recurring issue and appears to be of increasing concern. Many groups struggle to secure sufficient external funding which impacts staff retention and competitiveness. The reports also point to deficiencies in industrial partnerships, particularly in areas of industrial robotics, which often hinder the translation of research findings into practical applications. Methodological gaps and concerns about gender diversity are also highlighted.

Many of the weaker AUs often also lack specific strategies and in a number of cases struggle to produce much research because they lack critical mass, over-fragmenting their small manpower resources across too many areas. These cases tend to be in smaller universities as teaching pressures mean research time is limited and where the need to focus for the purpose of doing good research is counteracted by the need to provide a broad curriculum. These AUs suffer from challenges in recruitment, retention, and diversity, as well as inconsistent self-assessments and missed opportunities to align with evolving scientific and societal needs.

Strengths	**Weaknesses**
• Several strong groups, some at international level • Strong industry links in these cases • Tackling both fundamental and applied research • Strong groups had bigger PhD student cadres and successful programs	• Weaker groups lacked scale, focus, clear strategies and industry connections • They generally lack industrial and international networks, and are often hindered by being inward-looking • Weaker groups did less dissemination, eg through conferences • Low institutional funding for institutes limits ability to do more path-breaking research
Opportunities	**Threats**
• Increasing EU networking and funding • Improve dissemination • More rapid take-up of newer technologies • Opportunities to leverage AI in engineering and other applied fields • Increase industry interaction to raise quality and impact • Stronger mentoring relationships between old and new institutions.	• Lack of resources to increase strategic focus and scale • Too strong emphasis on applied work at the expense of smaller scale fundamental work • Insufficient local support • Lack of gender diversity

Table 3 SWOT on ICT as a whole

Engineering overall

Engineering research in Norway is of high quality, with international excellence in some areas and strong societal relevance and impact at a national level in others. The research excellence and organisation is generally more evident than the societal impact and the transition to emerging sectors and new opportunities is disparate, variable in impetus, and would benefit from stronger strategy and coordination.

Norwegian engineering research is generally strong in marine engineering. A significant level of funding is available which results in a lot of high-quality work, as reflected in the high-quality research carried out at NTNU and SINTEF. Research is very strong in oil and gas (O&G) related areas, ship related research areas like sustainability and optimisation of vessel performance are also well covered, and emerging areas, including storage and transport of new fuels and offshore renewable energy are explored by some research units (SINTEF, NTNU). Newer research groups at HVL and USN generally have less strong research activity, but they are seeking support for research from their local industries in their niche areas. Research in oil technology is variable, with some groups from SINTEF leading in terms of research quality and organisation, while others perform less well. In construction, there is a combination of significant international impact (NTNU and SINTEF) and good national quality (IuT, UiA and OsloMet) of research. Engineering technology research groups are very broad and their size, characteristics, challenges and potentials vary substantially, with civil engineering accounting for the biggest share of publication output. NTNU and SINTEF lead in terms of organisation and research quality, where some groups are active at an international level attracting competitive grants for European cutting-edge research. NTNU is by far the biggest contributor in Norway of scientific publications in energy technology, and the greatest proportion of the publications produced relate to energy and fuels.

Green energy research is internationally excellent in some areas with a strong correlation between research excellence and societal impact and strong impact. Overall the topics addressed by the research groups are well aligned with international trends and with societal needs and research is creating societal impact. However, there is a tendency to cover too broad a scope without a clear research strategy. This leads to loss of critical mass and undermines the group's international competitiveness. The Norwegian research in industrial technology is, in general, of very good international quality, with NTNU and SINTEF excelling at the international level and UiS and UiT performing well within their national networks.

Although the topics covered across engineering are critical for Norwegian society, expressing the societal impact of the research is generally underplayed.

Strengths	**Weaknesses**
• Thriving sub-disciplines in Information Engineering and Power Engineering due to their global relevance and strong infrastructure. • Research groups at NTNU and SINTEF in general stand out with respect to research quality, with several groups being internationally excellent level • Strong societal impact by SINTEF in areas of Thin film and membrane technology, Battery and hydrogen technology, Offshore energy systems, Active distribution system and Bioenergy, and by NTNU in Sustainable Energy systems with strong involvement of partners. • All research groups are covering research fields of strategic relevance and importance for the development of Norway, incorporating the specific Norwegian environmental conditions and requirements. • The infrastructure and equipment are generally modern and build a good research basis. • Strong industry collaboration in general enabling industrial grant funding. • Marine technology/ocean engineering research is very strong in Norway, including maritime systems, robotics and automatic systems. • SINTEF, NTNU, UIT and USN have strong societal impact due to their excellent research collaboration and/or knowledge transfer partnership with industry.	• Weak strategic planning in many units limits focus and measurable impact. • Less societal impact is generally found for research groups at some of the smaller universities • Lack of succession planning and over-reliance on individual research leaders • Lack of gender balance • The number of PhD students is rather low compared to scientific staff number and to some international standards. • Some groups show a moderate social impact or sub-optimal communication skills, even though the topics of this area can have a fundamental impact. • Relatively little international collaboration is noted in the research groups evaluated. • Groups are fairly reliant on RCN funding. • National grants and industrial collaboration can limit the number of high-quality publications and the international comparison.

Opportunities	Threats
• Leveraging global challenges like green energy and automation to enhance visibility and funding. • Expanding collaborations with international and industrial partners for research excellence and impact. • There is opportunity for some of the research groups at smaller universities to increase research, knowledge transfer and capacity to interact and create significant impact since the topics are of importance for society. • Digitalisation and sustainability are critical emerging topics of this panel, which perfectly align with the global issues of digital and green transitions. There are still plenty of opportunities to excel at international level. • Individual competences can be systemised through increased interdisciplinary collaboration and more intense use of shared national research infrastructures. • Future success of less strong new research groups (HVL and USN) could be supported by the institutions and the Research Council in terms of 'ring fenced' funding for a limited period. • Research groups could consider longer-term diversification in emerging areas like: marine and offshore related research in the areas of artificial intelligence and machine learning. • O&G companies provide a significant support for these RGs, this should be directed towards supporting new and emerging research areas, eg low carbon shipping and sustainability, offshore renewables. • Availability of a large number of oil & gas infrastructures with and for which new, more sustainable and efficient decommissioning and recovery technologies can be developed.	• Some structural inefficiencies and high teaching loads. • Limited societal impact in some groups which may hinder broader relevance and funding opportunities. • Lack of strategic planning for research, without specific and measurable goals and objectives means that current research is unlikely to reach and sustain a high international level. • The trend for funding to be increasingly for interdisciplinary work can reduce the funding available for low TRL-level (basic) research, draining the pipeline for future innovations. • Retention: international academics and industrial experts returning to 'home' countries due to changes in the governmental policies. • In some areas it is difficult to attract and retain academic staff since industry offers competitive salaries. • The continued strong demand for oil & gas engineers risks weakening or preventing the development of long-term strategic thinking, including in terms of training and demand for new skills and talent. • Lack of strategic planning for research, without specific and measurable goals and objectives means that current research is unlikely to reach and sustain a high international level. • Research activity for some of the smaller universities, e.g. Electrical power systems and Energy and Environmental Technology at (USN) and Renewable energy (UiA) is threatened by the stronger focus on education compared to research and lack of coherent and articulated strategy for the research groups.

Table 4 SWOT on Technology

2.2. Analysis from the research group level

EVALMIT's hierarchical design (Appendix 3) means that disaggregated information from the research group level evaluations is fed up to the administrative unit evaluations and on to the national report. This brief section reports two results from cross-analysis of the research group evaluations.

The panels reviewing the research groups in EVALMIT used a 5-point scoring system (see Table 23 at the Appendix) to make judgements about aspects of group performance. These scores were reported to the research groups and administrative units but are not made more generally available.

Figure 1 averages publication quality and societal impact scores by sub-field. It confirms the national committee's finding that there is a positive relationship between quality and relevance. Bibliometric indicators for Norwegian mathematics at the aggregate level are close to the world average (Section 2.3), but the panels evaluating research groups found high quality and relevance in many of the specific groups assessed in EVALMIT. While mathematics and ICT tend to cluster in the top-right quarter of the figure, the more traditional technology fields are scattered. It is clearly important to move green energy upwards and rightwards because the area is key to sustainability while also providing huge commercial possibilities. Marine technology is not a field where the amount of publication is rising much, but it remains crucial to Norwegian industry. The other technologies are faster-growing, suggesting they have high potential relevance that could be realised.

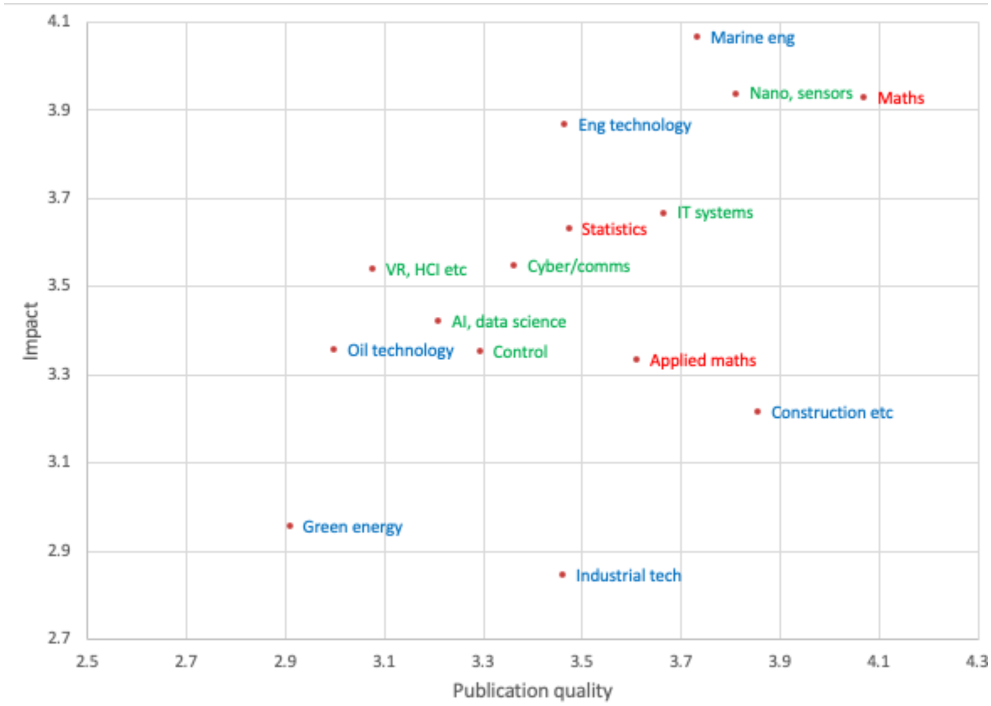

Figure 1 Publication quality and societal impact scores for EVALMIT sub-disciplines

Source: Mean scores per discipline, calculated from EVALMIT research group scores

Mathematics in red; IT in green; technology in blue

Figure 2 clusters the publication quality and impact scores by organisation. Simula's impressive position is driven by its strong academic funding combined with a relatively narrow specialisation in software, so it is an outlier. Leaving Simula aside, the established universities cluster at the top-right, while the new and smaller ones tend to be at the bottom-left. The institutes and the more mature among the new universities and colleges occupy the middle ground.

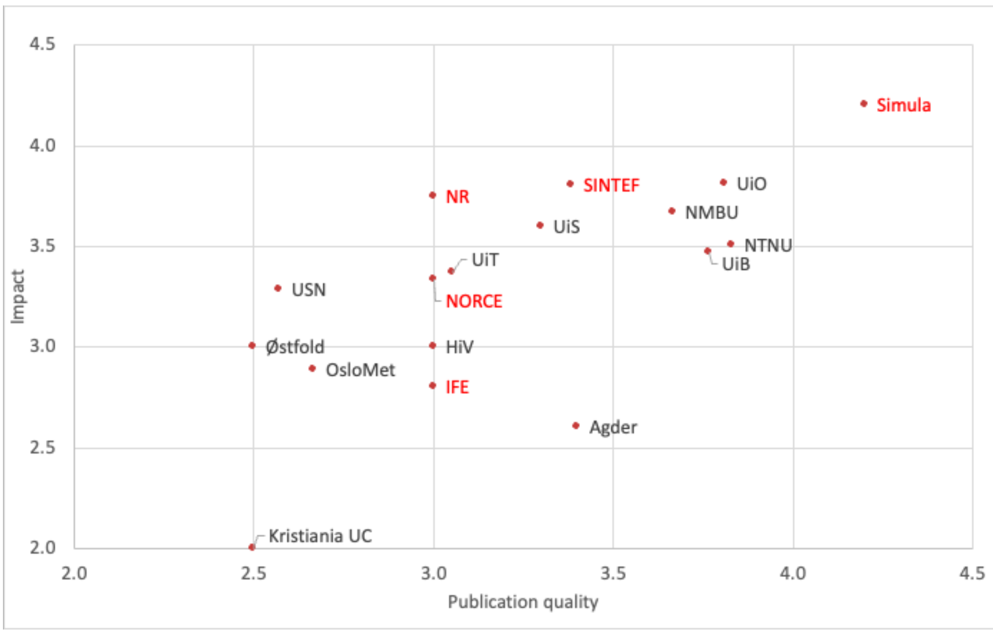

Figure 2 Publication quality and societal impact scores for EVALMIT institutions

Source: Mean scores per institution, calculated from EVALMIT research group scores. HEIs in black; institutes in red

The scores allocated to the research groups by EVALMIT panels support the national committee's finding that quality and impact are correlated, so research groups and policymakers alike should pursue both these goals together. Old-fashioned academic aloofness from societal needs does not pay off in MIT fields, at least.

The scores also confirm that the established universities and the institutes in scope have distinct roles in knowledge generation and use. It underscores that many smaller units, especially in smaller and newer colleges and universities, are disadvantaged and often underperform. This raises a policy question about whether and how to support their research ambitions, as against their important role in providing higher education across the whole country.

2.3. Supporting analysis based on bibliometric and statistical data

The MIT fields within Norway's overall science, technology, engineering and mathematics (STEM) output

Figure 3 shows numbers of publications in Norwegian STEM sub-fields in the past decade and an index of Norway's specialisation in these fields. Consistent with the longer-term pattern of economic and research system development in Norway, the Figure tends to show low specialisation and production of publications in basic fields and high specialisation in applied ones. Despite their economic importance, overall Norwegian specialisation in the three MIT fields varies around the world average of "1". At a more granular level, I is clear that the effort is more focused on industries and disciplines of national importance.

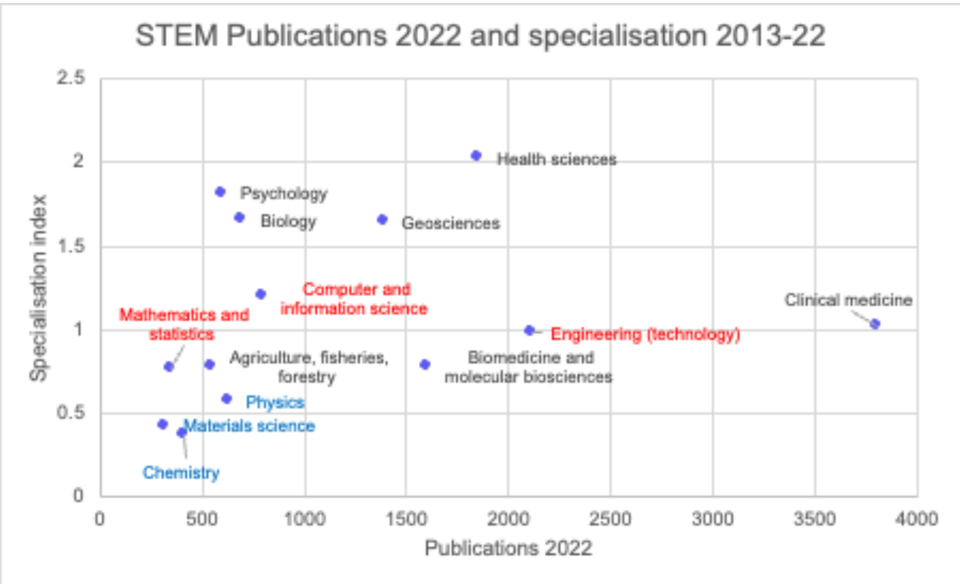

Figure 3 Norwegian STEM publications and specialisation indices for STEM subjects
MIT fields shown in red, Physical sciences in blue   Data from Karlstrøm et al (2024:5)

Figure 4 compares the mean normalised citation scores (MNCS) in Norway for each STEM sub-field with its specialisation index. An MNCS of "100" indicates that on average the number of citations obtained by articles in Norway is the same as that of all world publications in the field. Mathematics, Materials science and Chemistry are below average on both dimensions. While Norwegian publications tend to have higher MNCS in fields in which Norway specialises, the extent to which Norwegian publications in MIT subjects are cited is rather average. The Committee's evaluation in Section 2.1 indicates that at a more granular level there is more variation in performance,

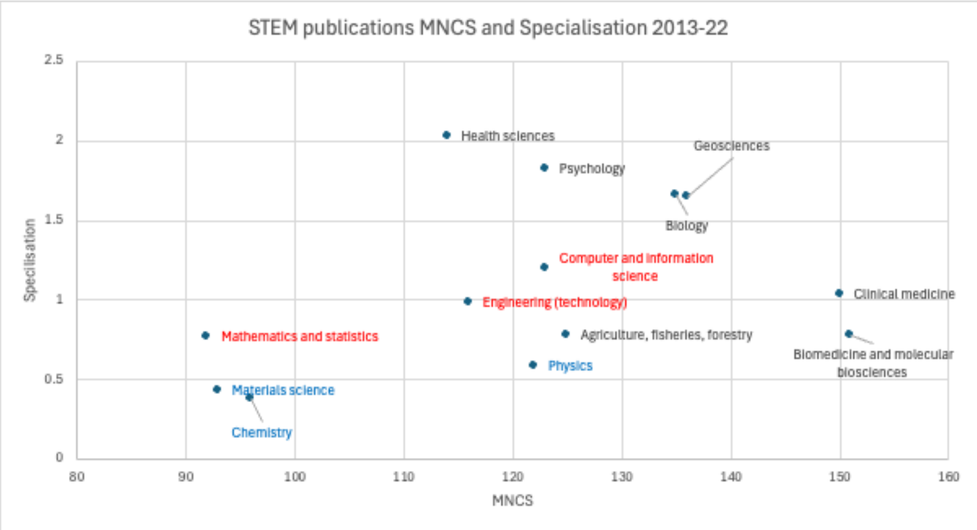

Figure 4 Mean normalised citation scores and specialisation indices for Norwegian STEM research
MIT fields shown in red, Physical sciences in blue Data from Karlstrøm et al (2024:5)

Mathematics, IT and Technology

Bibliometric evidence made available to the committee covers all Norwegian publications in MIT fields, not only those produced by researchers in scope to EVALMIT. This views research performance through the narrow lens of citation, but makes it possible to analyse Norwegian MIT at both field and sub-field levels and make systematic international performance comparisons.

Most of the bibliometric evidence refers to all publications with at least one author from a Norwegian institutional address, so in principle people in groups evaluated by EVALMIT will tend to be a sub-set of those considered in the bibliometric analyses. There may also be some inconsistencies between EVALMIT's field classifications and those of the Web of Science (WoS), on which the bibliometrics are based. Nonetheless, the bibliometric data provide an indication of how performance compares with international standards.

While MIT fields are important to the Norwegian economy, the proportion of Norwegian publications in 2013-2022 respectively in mathematics, ICT and Technology is close to the average for all countries considered in the WoS.

The numbers of Norwegian publications in 2022 in these fields differs widely among them. Table 5 shows the number published in each field in 2013 and 2022, and the growth across this period.

	2013	2022	Growth
Mathematics	560	650	16%
ICT	1460	1980	36%
Energy technology	410	530	29%
Marine Technology	230	330	43%
Other technology	600	990	65%

Table 5 Numbers of Norwegian papers published in MIT fields, 2013-2022
Source: Karlstrøm et al (2024:5)

Across the 2013-2021 period, the MNCS for MIT as a whole varied around 125, with no clear up- or downwards trend (Aksnes & Karlstrøm, 2025).

In the mathematics field as a whole, Norwegian the MNC has averaged 111, but has gently declined over the decade. Within mathematics sub-fields, Norway is specialised in pure and applied mathematics, but receives fewer than the world average number of citations. Citation performance is highly variable in other sub-fields that involve mathematics applications, with Norway doing a little better than average in interdisciplinary fields involving engineering and production, but below average in more abstract fields and in statistics.

In ICT, citation performance has risen during the last decade, with the MNCS averaging 118 across the 2013-2021 period. Norway is to a modest degree specialised in electrical and electronic engineering but spreads its research efforts across quite a range of fields. Citation performance in most sub-fields is well above the world average, especially in more applied rather than theoretical fields.

The available bibliometrics for Technology are presented in three sub-categories:

- The Norwegian MNCS in energy research fell sharply in the mid-2010's to around 110-115, but this is thought to be due to the publication of some exceptionally highly-cited work in the first half of the decade. Norway is very specialised in Energy and Fuels, obtaining above-average citation rates. In some other sub-fields, especially those orientated to engineering, Norwegian research is highly cited, but in other sub-fields more orientated to applied science (and Chemical Engineering) the citation rates are poorer
- In Marine Technology overall, Norwegian citation performance has hovered just above the world average for the last decade. Disaggregating the statistics, Norway is specialised in Marine, Ocean and Civil Engineering and in Oceanography with MNCS approximately in the range 110-125
- In Other Technology & Engineering, citation performance has fluctuated around an average of 118 during the past decade. Among the sub-fields, Norway is somewhat specialised in Civil Engineering, where the citation performance is just a little above the world average. The other sub-fields are rather disparate, with citation performance substantially better than average, especially in Mechanical Engineering

A more recent snapshot is provided by the 2019-2021 figures, when the MNCS for the major MIT fields were (Aksnes & Karlstrøm, 2025):

- Mathematics 96
- ICT 129
- Energy technology 116
- Marine Technology 102
- Other Technology and Engineering 113

Institutional performance

Karlstrøm & Aksnes (2024) provide a simple overview of the extent to which AUs' journal publications have been cited. Citation performance was diverse among the HEIs:

- NTNU submitted 15 AUs, 5 of which had 12.5% of their publications among the Top-10% most cited papers in their field; 4 had below 7.5% and the other 6 were around the mean
- UiT's Department of Electrical Engineering had 24.6% of its publications among the Top-10%, while the 8 other AUs were below (and in 4 cases far below) the average.
- Oslomet's 3 AUs were just below average
- UiB's 2 AUs a little further below
- While 4 of USN's AUs were a little further below average, the 5th one – Business and IT – had 31.7% of its publications among the top-10%
- Some individual AUs at new and small universities (Østfold, Western Norway, Agder) were strong, presumably reflecting success in building capability in a small number of specialisations.

Given their economics and applied focus, the institutes would be expected to have lower shares of highly-cited publications than the universities, and that is clearly the case for IFE, NORCE and NR. SINTEF's 6 AUs are distributed around the average. Simula's high citation rate stands out, but it is important to note that Simula has different economics to the other institutes and is very academically orientated.

AUs cited 50% or more above average were: NTNU's Departments of Computer Science and Natural Science, Simula, UiT Electrical Engineering, Agder Information Systems, UiO Informatics, USN Business and IT, and Østfold's Faculty of Computer Science, Engineering and Economics.

Emerging conclusions from the bibliometric analyses

Disaggregating the bibliometric data suggests that Norway tends to specialise in nationally and industrially relevant sub-fields of MIT, and to perform better than average at that level in terms of citations. This means that the industrial context encourages applied rather than more fundamental research, and this tends to translate to poorer levels of citation performance in fundamental and theory-based fields, adding credibility to the committee's assertion that fundamental research is under-supported in both funding and research group strategies.

There appears to be a particular issue in mathematics, where citation indicators suggest a modest performance. The committee's judgements about groups' performance suggest that there are some very good groups but that the 'tail' of modest performers is rather longer than in ICT or Technology. The committee points to a particular lack of funding support in pure mathematics, while citation performance is particularly disappointing in statistics and probability.

The bibliometric analyses also suggest there may be sub-fields – especially in technology – such as oil and green energy that need strengthening in order to support the green transition better. Such support would be important both to protect existing industry and to build the technological strength to make good use of the economic opportunities provided by the transition.

2.5. Open science

Administrative Units pretty universally claim to have adopted FAIR (Findable, Accessible, Interoperable, Re-usable) principles for curating research data so that they can be re-used. Some also mention that they also follow CARE (Collective benefit, Authority to control, Responsibility, Ethics) principles for sharing data on indigenous people's terms. However, there are no systematically-collected data about FAIR or CARE compliance for MIT as a whole.

Open access publication has been rising in Norway in recent years, as it has in other countries. NIFU (Karlstrøm & Aksnes, 2024) has analysed the extent to which the AUs represented in EVALMIT published their work in open access channels in 2022, based on publications listed in the Web of Science. The average unit archived 41.3% of its papers, so that pre-print versions can openly be obtained. It published a further 24.3% using 'gold' open access, so that the papers can be downloaded free of charge from the journal's web site. The remaining 34.4% of the output was not openly accessible. Since they are based on the Web of Science, these numbers exclude internal publications such as working papers, which are normally available free, as well as contract research (which is normally confidential when done for private customers, but free when done for government organisations).

Most of the AUs considered in EVALMIT are at major universities (Karlstrøm & Aksnes, 2024). Individual AU behaviour may deviate significantly from the averages given above, but there is no obvious pattern in the behaviour of the universities themselves. However, the newer and smaller universities tend to make less use of open access than the majors. Two of the more established new universities – Stavanger and Agder – tend to lie in between the two groups. OsloMet is hard to position, as its three AUs behave very differently to each other – though they all make heavy use of archiving.

Among the institutes included in EVALMIT[8], the Institute for Energy Technology and NORCE publish just over half their output in open access. SINTEF publishes over 75% of its output via open access – but makes heavy use of archiving to do this. However, the Norwegian Computing Centre behaves much like the average AU. These patterns suggest, first, that the traditional universities have better routines and possibly more money to pay article processing charges than the new universities and institutes and, second, that there is a learning curve among the universities that is driving up the share of open access publication over time.

[8] Simula was not included in the dataset analysed here

3. The general resource situation

3.1. Funding

Institutional funding

The higher education sector and the regional health authorities (which are not in scope to EVALMIT) are respectively governed by the Ministry of Education and Research and the Ministry of Health and Care Services. In contrast, the institutes are owned and governed by a wide range of ministries and foundations.

As in most Western countries, the public universities in Norway receive institutional funding from their parent ministry. Formally, this is allocated annually because the state budgets one year at a time. The annual letters of allocation from the ministry to the universities set broad goals for them in line with government research and higher education policy (especially the Long-Term Plan) and specify numbers of student places to be provided in various disciplines. The Ministry does not specify how much of universities' institutional funding is to be spent on research. However, NIFU calculates that in practice about 80% of the universities overall costs for research are covered by institutional funding. The remainder has to be won in competition from external funders such as RCN and the EU Framework Programme.

Different countries work with differing ratios of institutional to external funding. The exact ratios vary somewhat among years. However, at about 80%, Norway tends to be towards the upper end of the range together with, for example, Denmark and Switzerland. Other countries such as Finland, Sweden and the UK are more competitive, with institutional funding for research tending to cover about 50% of universities' research costs. As in most systems, the proportion of institutional funding for research provided varies among the universities in Norway, with the older traditional research universities getting a higher proportion than the newer universities and the colleges, which are more teaching-intensive.

Public research organisations or institutes often have multiple roles. Many function as 'government laboratories', and are typically owned and institutionally funded by a sector ministry. For example, the Marine Research Institute is owned the Ministry of Trade, Industry and Fisheries. It does some research, but most of its work is data collection and regulation on behalf of the ministry, for which it is paid directly. Other more research-orientated Institutes such as SINTEF and NORCE are among 33 institutes that satisfy RCN's criteria to be classed as 'research institutes'. Their institutional funding is channelled through RCN, which has also is responsible for evaluating them periodically. Norwegian research institutes typically get between 7% and 20% of their income as institutional funding, which is very low compared with equivalents in other countries such as the Fraunhofer institutes in Germany, TNO in the Netherlands or VTT in Finland, which typically get 30-40% institutional funding. Since they are more dependent on external market-based funding than their equivalents abroad, Norwegian research institutes tend to do more applied research and work at higher TRLs.

Different parts of the institute system are funded in different ways. The 'techno-industrial institutes' (research and technology organisations – RTOs – in international terminology) are the most relevant to EVALMIT.

Table 6 shows their economics in 2023. Institutional funding accounts on average for only 11% of their income, compared with the 30-40% provided in continental RTO systems such as TNO, VTT or Fraunhofer.

As the Table indicates, research in the techno-industrial institute sector is even more concentrated than that in the universities. SINTEF is the dominant force, and was originally set up in the 1950s as the industrial extension arm of the Norwegian Technological University (NTH, predecessor of NTNU).

	SINTEF	IFE	NGI	NORCE	NR	NORSAR	RISE:PFI	Sum	FFI	Total
Operating income	3954.6	1134.4	773.6	512.7	158.4	101.4	52.7	6,687.8	1,335.6	8,023.4
Institutional funding	507.5	91.0	62.3	52.0	18.1	9.6	3.7	744.2	1,315.2	2,059.4
Grant income	1,213.0	255.5	48.4	197.4	47.5	31.5	20.5	1,813.8	39.6	1,853.4
Contract income	1,095.1	156.1	363.7	164.7	62.4	31.9	24.9	1,898.8	894.0	2,792.8
International income	783.2	141.0	271.1	60.8	14.0	23.5	1.8	1,295.3	48.7	1,344.0
Government administration		404.1						404.1	19.0	423.1
Other operating income	225.5	65.8	8.5	14.6	3.2	1.0	1.3	319.9	27.8	347.7
Financial income	130.2	20.8	19.7	23.2	13.3	4.1	0.5	211.8	19.8	231.6
International share of operating income	*20%*	*12%*	*35%*	*12%*	*9%*	*23%*	*3%*	*19%*	*4%*	*17%*
Institutional share of operating income	*13%*	*8%*	*8%*	*10%*	*11%*	*9%*	*7%*	*11%*	*98%*	*26%*
RCN share of operating income	*32%*	*30%*	*14%*	*42%*	*32%*	*42%*	*41%*	*30%*	*0%*	*25%*

Table 6 Key figures, Norwegian Techno-Industrial Institutes, 2023 (NOK 1,000s)
Source: RCN Annual Report 2023, Techno-Industrial Institutes. Shaded institutes have not participated in EVALMIT. For historical reasons, Simula's institutional funding is provided directly by the Ministry of Education and Research

External funding

Norway merged its innovation agency and research councils to create the Research Council of Norway (RCN) in 1993. While RCN is an agency of the Ministry of Education and Research, it also acts as a research and funding agency for innovation and research for all the other ministries except defence. These other ministries themselves decide how much of their spending on research and innovation is devolved to RCN and how much they do for themselves. Almost all external funding in Norway comes either from RCN or the ministries. Unlike some other countries such as Sweden, Denmark, the USA and UK, there are few research funding foundations. Exceptions include the Cancer Foundation and the Trond Mohn Foundation, which mainly funds research at the University of Bergen and the associated university hospital (Haukeland), but these are very small by international standards.

In 2022, the ministries elected to spend NOK 11.4bn through RCN, of which

- NOK 7.3bn (51%) was spent on external competitive research and innovation funding, split
    1. NOK 4.1bn (56%) to the higher education sector
    2. NOK 2.9 bn (40%) to the research institutes
    3. NOK 0.3 bn (4%) to the regional health authorities
- NOK 1.1 bn was used for institutional or 'core' funding for the institutes overseen by RCN

In current money, RCN invested just under NOK 4bn in MIT fields in 2022.

Table 7 shows RCN's project funding of the major disciplines in real (2015) terms. The largest grouping is Technology (38%), followed by Mathematics and Natural Sciences (22%), which rose respectively by 31% and 48% in real terms in 2012-2022.

Disciplines	Cumulated real (2015) MNOK	Shares	Growth 2012-2022
Humanities	2,936	4%	40%
Agriculture and fisheries science	5,874	7%	-29%
Mathematics and natural sciences	17,335	22%	48%
Medicine and health	9,893	13%	36%
Social sciences	11,987	15%	65%
Technology	29,750	38%	31%
Other	1,283	2%	204%

Table 7 RCN Real-Terms Project Funding, Major Disciplines, 2012-2022 (Millions of 2015 NOK)
Source: RCN

Table 8 shows the proportion of different funding instruments in MIT funding and total RCN grant funding. Bottom-up, researcher-initiated projects tend to lie in the “Independent projects” category, or in some cases in centres of excellence funded under “institutional measures”. The Table is therefore consistent with the applied focus of MIT research.

Funding instruments	MIT	All fields
Independent projects	8%	16%
Infrastructure and institutional measures	23%	21%
Networking measures	10%	7%
Programmes	57%	54%
Other	2%	2%
Total	100%	100%

Table 8 Share of funding instruments in RCB grants, 2012-2022 (real prices) for MIT fields and all grants
Source: RCN

Funding acknowledgements from articles published in 2020-2022 confirm that RCN is the dominant funder in EVALMIT fields, acknowledged in 78% of articles[9]. The EU is acknowledged in 21%. Two companies (Aker BP and Hydro) are cited in about 1% each. The remaining funding is from various parts of the Norwegian state, except for 2% acknowledging the Trond Mohn Foundation in Bergen.

There is no comprehensive statistical source showing all the sources of funding used in Norwegian MIT research. NIFU’s analysis of funding sources for Norwegian publications in the MIT fields found that RCN is acknowledged in about 60-70% of publications in each of the five EVALMIT fields. The EU funds close to 20% in most of these fields, but only about quarter as much in marine technology, which tends not to be an EU priority. Mathematics and ICT articles acknowledge industrial funding much less than the other MIT fields.

[9] Source: NIFU Insight 2025-2. NB that some articles acknowledge more than one funding source

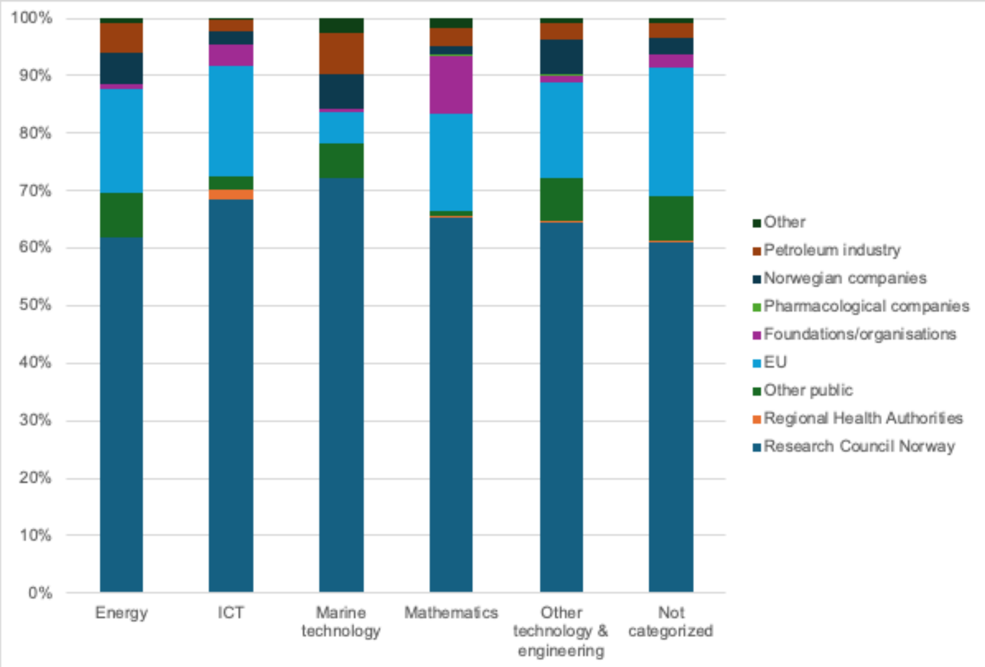

Figure 5 Proportion of Norwegian publications in 2020-2022 acknowledging various funding sources in mathematics, ICT and technology
Source: NIFU Insight 2025-2

EU Framework Programme funding

In 2022, RCN and the EU Framework Programme together provided a total of NOK 14.2 bn to research in Norway, with 80% of the funding coming from RCN and 20% from the FP.

Figure 6 differentiates between funding in MIT fields received by Norwegian research-performing institutions in the Excellent Science programmes and the innovation and societally-orientated programmes within the Framework in 2020 to 2022. Norway's funding is mostly in the second category. The Figure also shows that funding from the Framework Programme for Norwegian MIT fields is very skewed, with SINTEF, NTNU and UiO winning around €220m in the period, suggesting that there is substantial headroom for other organisations to win more money from the Framework Programme.

The EVALMIT research group and administrative unit reports echo this message. Especially for groups outside NTNU, SINTEF and UiO, the reports emphasise the need to diversify funding sources beyond RCN by making better use of the opportunities provided by the Framework Programme. One of the reasons given for this is to reduce the risk associated with high dependence on a single funder. The committee feels this risk is exaggerated to the extent that RCN has a range of funding instruments for fundamental and applied research and innovation – in effect, RCN contains different sorts of money. However, the more important reasons given for seeking Framework Programme funding are to participate more in international research and innovation networks and to build scale. As was indicated in Section 2.1, these ambitions align with success-factors in MIT research. While the evaluation reports rarely go into more detail about the benefits of Framework Programme participation, this not only brings opportunities to learn from and demonstrate capabilities to international researchers but also to industry. Framework Programme participation is dominated by established networks that evolve slowly over time and that win projects through a combination of capacity and track records. There are strong barriers to entry, but once one becomes a trusted network member the likelihood of participating in successful proposals rises dramatically (Arnold, 2012).

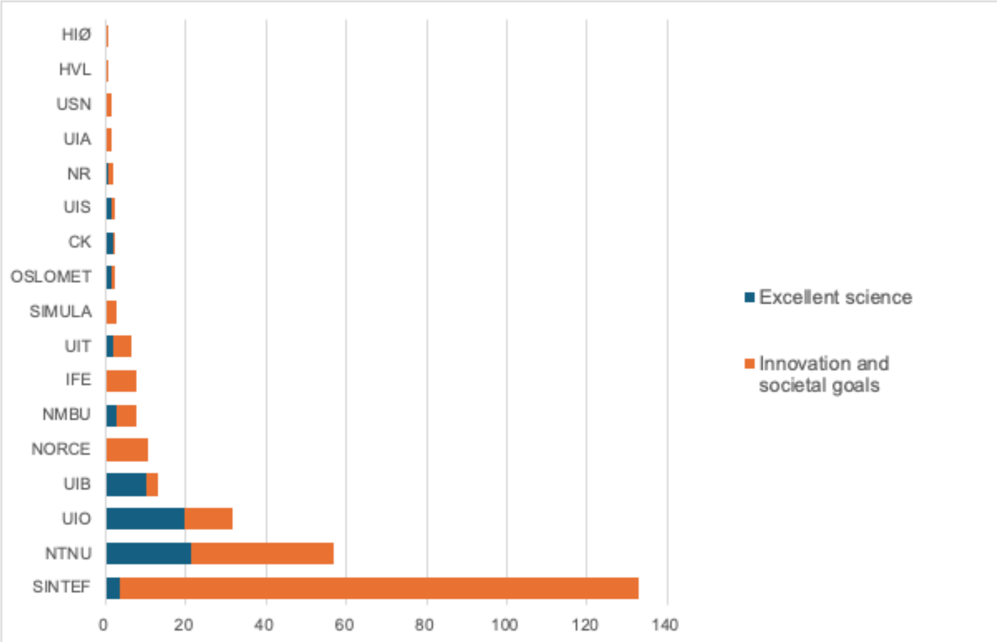

Figure 6 EU Framework Programme funding granted to Norwegian organisations by programme goals, 2020-2022
Source: RCN

3.2. Personnel

The Administrative Units included in EVALMIT employed a total of about 5,580 researchers in 2021 (the latest year for which the national statistical office SSB publishes a consistent set of data). Two thirds (3,700) of these researchers were in the higher education sector and the other third (1,900) in the institutes. Consistent with a longer-term trend for the higher education sector to grow faster than the institute sector, the growth among higher education researchers in units in scope to EVALMIT between 2013 and 2021 was 60% (1,430) while the number of institute researchers grew by only 25% (380 people).

The higher education researchers in scope to EVALMIT were younger (average 39 years) than those in higher education as a whole (average 45). The average age of the (full) professors in AUs submitted to EVALMIT was 54, with a range from 45 to 61. Some 26% of professors in the EVALMIT units were 62 or more years old and therefor eligible for retirement (though the official retirement age is 67). In thirteen[10] AUs, the share of professors aged 62 or more was one third or above, underlining the need for deliberate succession planning as a component in unit strategy. This signals a generation shift, which is on the one hand a threat because of the need to replace retirees, though surprisingly little is said in the AU and research group reports about succession planning. On the other hand, it is an opportunity to set new research directions by replacing retiring professors with other people specialising in new areas. These would not necessarily be professors – there is a case for recruiting some people at lower levels to enable organic growth. This opportunity is especially relevant in relation to the green transition – shifting research foci from fossil fuels to renewables and new materials – and new technologies in ICT such as AI, quantum computing and communications,

[10] NTNU Departments of Electronic Systems, Energy and Process Engineering, Geoscience and Petroleum, and Structural Engineering; UiA Faculty of Engineering and Science; UiS Department of Petroleum Engineering; UiT Department of Building Energy and Materials Technology, Computer Science and Computational Engineering, and Mathematics and Statistics; USN Department of Business and IT; and all 3 AUs from USN.

and digitalisation more broadly. This strategic opportunity was also little discussed in the self-evaluations presented to EVALMIT.

The growth in the research workforce at the university units in scope to EVALMIT has been strongly supported by people who took their PhDs outside Norway. The proportion of research staff who took their PhD abroad has risen from 28% in 2013 to 40% in 2021. The proportion is highest (48%) among postdocs and researchers, lowest among associate professors (33%), and very close to the average among full professors (41%). There is no obvious connection among subjects and having an above-average proportion of PhD-holders except among units with 'Mathematics' in their title which all did so in 2021.

	Researchers	Percentage
Total	3,704	100%
Full professors	746	20%
Associate professors	768	21%
Researchers and postdocs	595	16%
PhD students	1,595	43%

Table 9 Shape of the HE academic hierarchy in EVALMIT units, 2021
Source: Rørstad & Wendt (2024/15)

3.3. Research infrastructure

Norwegian MIT research benefits from extensive and high-quality national research infrastructure and access to EU infrastructures and the ESFRI system, as well as older multilateral facilities such as EMBL and CERN. Access to infrastructure is not only important to carrying out research but also can be a key factor in making Norwegian researchers attractive partners in international research collaborations, such as the EU Framework Programme.

Table 10 shows how many EVALMIT administrative units use the main infrastructures available. There are many more facilities in addition which, as the table indicates, are only used by one or two units.

Many of the national infrastructures reflect specific Norwegian research foci.

- There are extensive and high-quality marine engineering facilities for hydrodynamic and strength and fatigue assessment of ships, O&G platforms and offshore renewable energy structures. Many of these are in and around Trondheim, where a Norwegian Ocean Technology Centre is being built at a cost of about NOK 10bn, and is to be run by NTNU and SINTEF
- SINTEF Ocean is the host institution for three national infrastructures: PLANKTONLAB (The Norwegian Centre for Plankton Technology) for bio marine production/biomass production and harvesting of plankton from the sea; The Marine Technology Centre for research and development in shipping, marine equipment, ocean energy, petroleum and other ocean industries; OceanLab (Ocean Space Field Laboratory) for technological developments and digitalisation of the ocean, including an ecotoxicology laboratory, environmental and biochemical analysis, and oil laboratory
- The NORCE E&T Division hosts two national infrastructures: OpenLab Drilling for research and technology development within drilling and well operations, and Ullrigg Test Centre, which is a full-scale test and piloting centre for technology, systems, methods, and solutions in drilling and well activities. It is a partner in four infrastructures: the Norwegian P&A Laboratories, a national Plugging and Abandonment (P&A) infrastructure being established at NORCE, SINTEF, UiS and NTNU

National infrastructures	No of user AUs	International infrastructures	No of user AUs
Sigma2	11	ESA	12
NorFab	8	CERN	11
eX3	7	ELIXIR EMBL	6
Manulab	5	ECCSEL	7
NorPALabs	5	European Synchrotron Radiation Facility	4
ELIXIR.NO	4	ESS	3
Norwegian Advanced Battery Laboratory Infrastructure (NABLA)	4	LUMI Supercomputer	3
Norwegian Artificial Intelligence Cloud (NAIC)	4	SIOS Svalbard	3
NcNeotron/ESS	4	EuroHPC-JU EuroHPC Joint Undertaking,	2
OceanLab	4	Europ Bio-imaging ERIC	2
Norwegian Biorefinery Laboratory (NorBioLab)	4	ESRF-EBS	2
HydroCen	4	39 others	1 each
SmartGrid	3		
ZEBLab	3		
CCSEL Norway CCS RI	3		
HighEFFLab	3		
Smart Building Hub (SBHUB)	3		
14 other infrastructures	2 each		
64 other infrastructures	1 each		

Table 10 Numbers of administrative Units using national and international infrastructures
Source: EVALMIT Administrative Unit reports

- NorFab, the Norwegian infrastructure for micro and nano fabrication, provides a wide variety of micro- and nanotechnology (MNT) fabrication and characterisation services, as well as education and training, vital to both basic and applied research. The State-of-the-art laboratories are of great importance for various research activities in MNT, promoting collaboration on a national level, fostering a robust national competence, enhancing international project collaborations. Groups at NTNU, USN, UiO and at SINTEF make use of the facilities and contribute to building competence in this field
- Norway's geography makes it an excellent base for environmental, climate and geological observation. IOS Infranor, which is an international infrastructure on Svalbard to monitor impacts of climate change and understanding of how the change affects the arctic environment and its ecosystems; TONe, Troll Observing Network, to enable environmental research and understanding of the role of eastern Antarctica in the climate system, and how climate change will impact fauna and primary production; EPOS-N, a web-based software to visualise, sort and analyse different types of geoscientific data, volcanic eruptions, slope instabilities, tsunamis, tectonics and Earth surface dynamics. NORCE E&T also make use of the ECCSEL Infrastructure, Svelvik CO2 Field Lab, for testing digital acoustic sensing for monitoring CO2 injection and storage; and NIRD both for access to High-Performance Computing and large-scale data storage
- Within international infrastructures, NORCE has a long track record in radar satellite remote sensing and are an ESA Expert Support Laboratory for the Envisat and Sentinel-1 missions, part of the Copernicus satellite infrastructure. Norwegian membership in the Copernicus program is at the core of the satellite remote sensing activities at NORCE, and a critical infrastructure for the satellite research activities and service development. It also uses the ESFRI: European Next Generation Incoherent Scatter radar infrastructure to develop a space debris tracking system; the European Multidisciplinary Seafloor and water column Observatory; and is responsible for developing and maintaining parts of the core services for the e-Infrastructure of the European Plate Observing System; and the Aircraft infrastructure, and SAR satellite snow products for the Svalbard Integrated Arctic Earth Observing System
- Currently, research consumes rapidly-growing high-performance computing (HPC) power. Norway has created a single national HPC centre – Sigma2 – which is co-managed by leading

Norwegian universities and is currently testing a new supercomputer in former mine workings outside Trondheim. This is an important example of the power of building a single national centre in a technology where scale is very important

Research infrastructure is cost-heavy, and parts of the infrastructure constantly need renewal, so infrastructure projects need appropriate business models to cover their costs. As the Ocean Technology Centre illustrates, these costs can be very large. A clear strategy will be needed for facilities maintenance, use and development to ensure funding covers future overheads. It also needs to be clear about how it is positioned in the context of national and international roadmaps to ensure alignment with wider national and international needs, raise the profile of the facilities to support continued use, and raise awareness of the Centre and its partners more widely.

4. PhD training, recruitment, mobility and diversity

4.1 PhD training

EVALMIT submissions at research group and AU level described numbers of PhDs being trained, but understandably it was difficult for committees directly to form a view of the quality of PhD education at individual AUs. Unsurprisingly, the larger institutions tended to have more formal arrangements for mentoring and training PhD candidates, and had the numbers of PhD candidates allowing sustainable provision of doctoral training classes in addition to individual supervision. Many groups had enough capacity available to train more PhDs, but were not always able to recruit them. Ten of the AUs had numbers of PhDs in single figures, and are likely to be sub-critical.

The ratio of PhD students to full professors across the EVALMIT HEI AUs in 2021 was 2.1 (Table 11). The ratio of PhD students to full and associate professors was 1.1, suggesting that research productivity in terms of both research and PhD production was low. There was a wide variation in these ratios at the individual AU level, however. The ratios also need to be understood in the context of differences in the importance of teaching versus research. Low ratios of PhD candidates to professors at smaller institutions will be strongly influenced by high teaching loads, with some of the professors focusing on teaching rather than research.

Organisations	No of AUs submitted by the institution	PhD students per full professor	PhD students per full or associate professor
Kristiania	1	0.6	0.2
NMBU	1	1.9	0.7
NTNU	15	2.8	1.6
Oslomet	3	1.0	0.4
UiA	2	1.5	0.7
UiB	3	2.9	1.2
UiO	2	2.2	1.4
UiS	3	2.2	1.1
UiT	9	2.5	1.0
USN	5	0.9	0.4
HiV	1	1.2	0.4
All	43	2.1	1.1

Table 11 Ratios of PhD students to professors, 2021

Source: Calculated from Table 3.4 in Rørstad & Wendt (2024/15), which shows the full data set at the individual AU level

4.2 Recruitment

Many of the AU reports describe difficulties in recruiting faculty members and students at all levels. These are especially important where alternative, better-paid posts exist in industry. Mobility of researchers in Norway is impeded in many cases by the ‘two-body problem’ where both partners in a family have professional or academic jobs, so that changing location can only be done if two suitable positions can be found simultaneously.

As Section 3.2 points out, growing numbers of faculty members are not of Norwegian origin, and the same is true of students, especially at PhD level, reflecting changes in Norwegian demographics and employment preferences. Recruitment is especially difficult outside the major cities.

4.3 Mobility

EVALMIT self-evaluations rarely contain any numbers, but committees and panels frequently comment on the (long-established) problem that Norwegian researchers tend to be reluctant to take up mobility opportunities. This is often attributed to the high level of welfare in Norway and the family issues raised by mobility, such as the need for spouses to have an income and the loss of benefits such as childcare. There are no opportunities to take sabbaticals in the institutes, and few in the higher education sector outside the traditional universities. Low levels of mobility seem therefore to be supported by a combination of low demand and low supply in a high-income country where the short-term benefits of mobility are felt to be limited. This runs counter to the more general belief in global research communities that mobility is career-enhancing because it builds reputations and new networks, prevents in-breeding in research groups, and supports the transport of new thinking between research communities. Complexities in tax regimes, including the Norwegian one, have also been mentioned as barriers to mobility, so it could be useful for the institutions and RCN to explore this question and potentially to offer advice alongside the mobility schemes in operation.

4.4 Gender equality and diversity

Women's positions are slowly improving in the universities, but they remain poorly represented in the EVALMIT units, with those in higher education in 2021 making up 25% of the researcher workforce, compared with 51% in the higher education sector as a whole.

	Professors	Associate professors	Researchers & postdocs	PhD students	Total
2021	15%	26%	24%	29%	25%
2017	12%	27%	26%	28%	24%
2013	10%	24%	23%	27%	22%

Table 12 Share of women in EVALMIT higher education units at different career stages
Source: Rørstad & Wendt (2024/15),

The slow growth in female participation is consistent with international trends in large-scale surveys of authorship of journal articles. Jemieniak and Wilamowski (2024).calculate that the convergence between female and male shares of authorship is reducing over time, making it unlikely that equality will be achieved without additional policy measures Female participation varies both by country and by field. The female share in mathematics is about 21-27%, engineering about 24-28%, and computer science about 26-29% (Jemielniak & Wilamowski, 2024; Elsevier, 2024).

Research group and AU reports university point to the problem of gender imbalance, especially in ICT and mathematics. Groups and AUs universally have policies aimed at reducing the imbalance, though few were able to describe specific actions through which they are reducing it.

The share of women among EVALMIT institute researchers was 29%, up from 26% in 2013. Some 68% of RI researchers have a PhD, compared with 93% in the HE sector. Only 20% of institute researchers had a foreign PhD in 2021. The institute researchers' average age has been stable at about 43 during the 2013-2021 period, while the proportion aged 62 or above is only 7%, suggesting there are fewer succession planning issues than in the HE sector.

Data on wider diversity, other than shares of people in various positions born outside Norway to non-Norwegian parents, are hard to find. The reports contain nothing to suggest that this change raises issues. This is surprising, since such demographic changes tend to raise questions of brain drain and gain, culture, language and research group sustainability, among others. Unless such issues are monitored, it will not be possible to address questions about them using a factual basis.

5. Research cooperation nationally and internationally

5.1 Administrative units' cooperation within and between sectors

Norwegian research cooperation patterns in MIT appear consistent with the geography and history of the research-performing organisations.[11] Figure 7 maps co-publication among these organisations in 2020-2022, with the diameter of the nodes being proportional to the number of articles published and the width of the lines being proportional to the number of joint publications between the institutions at the end of the lines.

At this overall level (and in most of the sub-fields), the NTNU and SINTEF are the dominant actors, reflecting NTNU's historic role as the national university of technology. SINTEF was originally conceived as the industrial extension department of NTNU, but has grown over time almost to become the national research and technology organisation, rather like TNO in The Netherlands or VTT in Finland. One reason SINTEF can operate with much lower institutional funding than TNO or VTT is its symbiotic relation with NTNU, which is most visible in the large number of (primarily) NTNU PhD candidates co-supervised, or in practice working in the labs, at SINTEF.

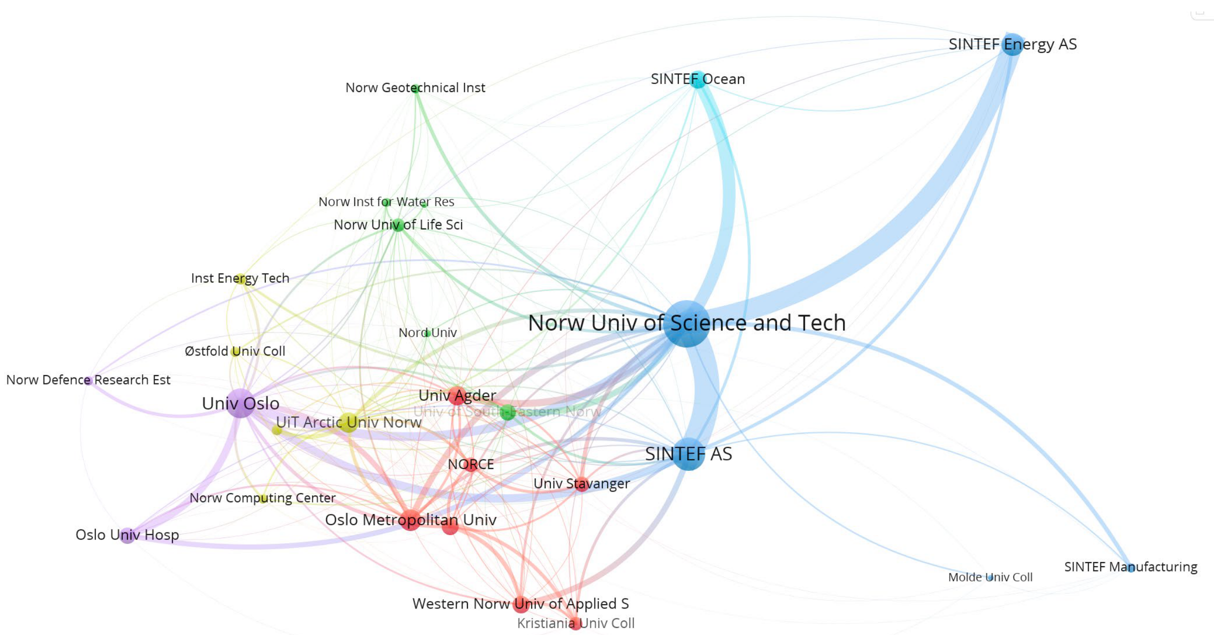

Figure 7 NTNU as the spider in the web of Norwegian MIT co-authorships, 2020-2022
Source: Aksnes & Karlstrøm (2025)

Figure 7 shows a second, smaller cluster around UiO, whose partners are more likely than those of SINTEF to be universities rather than institutes. The shape of these two clusters is partly driven by UiO's greater orientation towards natural sciences, mathematics and software while NTNU has focused more on 'hard' industrial technologies. It also reflects the fact that Norway's original national institute of technology (*Sentralinstituttet for industriell forskning*) was absorbed by SINTEF in 1993. UiO's links to SINTEF are sometimes to the parts that were absorbed by SINTEF and which tend to remain located close to UiO. (Norway also has a third natural university-institute network with about

[11] Most of this section summarises information from the same source, at both MIT level and at the level of the five fields into which the authors divide MIT. The reader should note that this and the other network analyses treat SINTEF AS and the industrial divisions (Industry, Digital, Marine, etc) as separate entities

800 employees, which is developing around UiB through the merger of ten mostly West-coast institutes into NORCE. This is thematically diverse and therefore not visible in analyses of MIT.)

Aksnes and Karlstrøm (2025) additionally describe the different characteristics of individual fields within Norwegian MIT:

- The national co-publication pattern in mathematics is dominated by two clusters: a marginally bigger one centred on UiO, and another on NTNU. The pair with the largest number of joint publications, however, is UiO and NTNU, reinforcing the extent to which the Norwegian mathematics community forms a single network. This network is dominated by universities – there are only a few institute nodes, of which SINTEF Ocean is the biggest
- The ICT network is more heterogeneous, with overlapping networks centred on NTNU and UiO. SINTEF also appears as a major node, with connections not only to NTNU and UiO but also to a list of other universities
- The Energy network is heavily dominated by NTNU, which is strongly linked to various parts of SINTEF. UiO is at the centre of a much smaller network with a different set of institutes – notably the Institute for Energy Technology (IFE), the Norwegian Defence Research Establishment and CICERO, all in the vicinity of Oslo
- Marine technology is similarly dominated by the NTNU-SINTEF pair, with UiO at the centre of a much smaller sub-network
- Reflecting its heterogeneity, the 'Other technology' network has many members but they are nonetheless overshadowed by the scale of the NTNU-SINTEF pair

5.2 Administrative units' international research cooperation

Table 13 shows Norway's pattern of international co-publication in MIT. Unsurprisingly, given their size, China and the USA are the biggest cooperation partners, followed by Germany and the UK, which have traditionally had the major relevant research communities in Europe. The other Nordics (Sweden, Denmark, Finland) together make up 17%. The top-9 countries account for just over half the co-publications, so while these are important partners none is big enough to overshadow the collaboration pattern.

Country	No collab pub	Percent	Country	No collab pub	Prop all pub
China	1529	10 %	**Canada**	477	3 %
USA	1281	8 %	**Switzerland**	310	2 %
UK	981	7 %	**Australia**	292	2 %
Germany	970	6 %	**Finland**	256	2 %
Italy	785	5 %	**Austria**	255	2 %
Sweden	724	5 %	**Brazil**	239	2 %
India	638	4 %	**Iran**	229	2 %
Netherlands	537	4 %	**South Korea**	214	1 %
France	527	3 %	**Russia**	206	1 %
Denmark	501	3 %			
Spain	492	3 %	**Total**	8671	58%

Table 13 International co-publication in MIT fields, 2020-2022
Source: Aksnes & Karlstrøm (2025)

The major MIT fields have different international collaboration patterns. Based on 2020-2022 publications, the following proportions of Norwegian publications have international co-authors

- Mathematics 63%
- ICT 56%
- Energy 61%
- Other technology and engineering 61%
- Marine technology 43% (Karlstrøm & Aksnes, 2024)

Table 14 shows Norway's top-5 co-publication partner countries for each of the main MIT fields, the proportion of co-publication that is with China and the USA, and similarly for the Nordic countries as a group and individually. Despite their proximity, the other Nordic countries are not especially frequent partners. In research terms, these patterns appear healthy. However, the importance of China is an issue in terms of knowledge export controls. In the current geopolitical climate, it is unclear whether co-operation with US researchers will become more complex.

	Mathematics		ICT		Energy		Marine		Other technologies	
No. articles		1123		3252		1145		289		1853
Top-5	US	12%	CN	9%	CN	11%	CN	13%	CN	13%
	DE	10%	US	8%	IN	7%	US	8%	US	8%
	UK	9%	DE	7%	US	7%	DK	5%	UK	7%
	IT	6%	UK	6%	DE	7%	UK	5%	IT	7%
	FR	6%	IN	5%	DK	6%	NL	3%	SE	6%
CN		5%		9%		11%		13%		13%
US		12%		8%		7%		8%		8%
Nordics		7%		9%		11%		5%		13%
Of which, SE		5%		5%		5%				6%
DK		2%		2%		6%		5%		5%
FI				2%						2%

Table 14 Top co-publication partners per MIT field, 2020-2022
Data from Karlstrøm & Aksnes (2024) NB these data are taken from longer lists of top co-publication partner countries, so small percentages from other Nordic countries will have been omitted

In 2022, 31.7% of Norwegian scientific publications involved international co-authors, placing Norway in a group with other small countries like Finland and Estonia with a very high propensity to international co-authorship[12]. The proportion of European authors co-publishing internationally has risen during the life of the EU Framework programme. For obvious arithmetical reasons, country indicators of international collaboration tend to be inversely related to population. In Luxembourg, international co-publication is nearly inevitable; in China it is less so, and the recent decline in the overall proportion of articles with foreign co-authors is likely to be driven by the dramatic growth in Chinese publications during recent years.

In aggregate, 21.9% of the articles published by AUs submitting to EVALMIT involved national co-authors, and 53.8% international co-authors. Individual AU behaviours are rather variable, depending to some degree on their discipline. For example, about half the NTNU and UiT AUs co-publish with other Norwegian organisations only to a rather small degree. In contrast, UiS, Western Norway and Østfold publish little with domestic partners but much more than average with foreign ones. SINTEF AUs tend to publish more than average with national partners and a little less than average internationally. The other institutes show a similar pattern, though Simula stands out for publishing

[12] OECD Bibliometric indicators 2024 edition, based on SCOPUS

75% of its articles with Norwegian authors but at the same time more than average with foreign institutions (Data from Karlstrøm & Aksnes (2024) Table 4).

EVALMIT AU reports imply that the more successful research groups and administrative units are already well integrated into international networks, but that all groups would benefit from greater participation in the EU Framework Programme. This may become especially important if current tensions among international trading blocs continue to increase, leading to restrictions on cooperation.

6. Societal impact and the role of research in society

As indicated in Section 2.1, successful applied MIT research requires understanding of the industries in which research results are likely to be applied and therefore contact with users.

The committee's impression was that the authors of the administrative units' impact cases were not very familiar with researching and writing such things. About a fifth of the self-assessments did not include any cases. Many of the cases were at an early stage, where little impact had yet occurred. Most of the cases submitted discussed the research involved and asserted there was societal impact, but provided few or no indicators to support the claim – even if in many cases the claims were credible. Future evaluations could provide more guidance on how to evidence impact claims, though it should be noted that producing evidenced impact statements can involve a substantial amount of work.

The committee selected 35 examples where significant and specific effects had been identified to analyse more closely. The impact statements from research institutes tended to be more concrete and better evidenced than those from universities. This is unsurprising, as the institutes generally work at higher TRLs and to a greater extent co-produce innovations with their customers, so they are better positioned to understand short-term impacts. Some university groups have similar relationships, but by no means all do so.

The set of impact cases shows some other distinct patterns:

- Impacts easily cross disciplines, so mathematics can create impacts on health, ICT on energy technology, and so on. In many cases, impacts resulted from different departments working together
- Few cases involve the creation, packaging and transfer of intellectual property
- Where spin-offs take place (which is in a small minority of cases), they tend to appear in clusters over a period, reflecting the research groups' strong understanding of the demand side. They therefore tend to address established industry, rather than being the more speculative, 'technology push' kinds of firm normally associated with Silicon Valley, Cambridge, UK and so on
- An exception is Simula, which spins off software firms
- It was possible to identify only one clear case of AI-related impact (Tsetlin machines – see below)

These trends appear consistent with the structure of Norwegian research and industry in EVALMIT-related sectors, with a tendency towards incremental innovation in established industries. This underlines the question whether the research and innovation system is sufficiently able to support the more disruptive changes likely to be needed in talking the societal challenges and the challenges increasingly arising from the changing global context.

The following case summaries are intended to illustrate the variety of impact that is possible, They are all, to varying degrees successful examples (unsuccessful ones have no impact, by definition). Their scope ranges from the very local example of reducing the damaging effects of ship wakes in coastal waters to global influence on the design and implementation of offshore wind turbines.

NORCE – Automated drilling

This case builds on research at NORSE and its predecessors in Stavanger going back to the 1980s on how to optimise drilling in the oil and gas industry. Like many of the institute sector's impacts, it is based not on a single project but a longer research agenda conducted in interaction with industry over many years. The research has aimed to understand what is happening underground during drilling, to optimise its efficiency and increase its range of applications, using mathematical models, laboratory-scale experiments and full-scale trials at the Ullrig drilling infrastructure at NORCE. From 2000, the work has focused on real-time control of drilling, increasing efficiency and making it possible to drill from unstable platforms, especially floating platforms. NORCE's predecessor institute span off a service company, Sekal, in 2011 through which the researchers have been able to deliver a stream of commercial software to the company and the market, supporting drilling at over 1,000 wells, and in 2021 demonstrating AI-based autonomous control of drilling in a joint industry project supported by RCN. Sekal is now among the market leaders in drilling automation. Independent analysis by Rustad has identified large potential for productivity improvements as well as reducing the carbon footprint of the drilling process itself.

SINTEF Energy Research – Grøft Design (Trench Design)

This case is based on work by SINTEF on two RCN industrial innovation (IPN) projects between 2014 and 2022. This developed a tool to support the design of high-voltage underground transmission cable installations needed to address increasing electricity demand caused by decarbonisation. The projects were initiated in response to a request from power distribution companies. The resulting computer-aided design tool – Grøft Design – allows designers to explore alternative cable and trench designs as well as alternative materials for filling trenches, all of which affect the magnetic and thermal properties and the carrying capacity of the installed cables. Grøft Design claims that it increases electricity throughput by 5-20% compared with traditiomal design methods. The first version of the software was launched on the market in 2019, and is promoted by REN, which is a company jointly owned by the electricity distributors that sets standards and promotes good practice in electricity distribution. At this stage, the claimed performance improvements appear not to have been independently verified.

Norwegian Computing Centre (NR) Covid-19 modelling

As in many other countries, Norway recruited the help of a research group at the start of the Covid pandemic at the end of 2019 to model the transmission and effects of the disease. NR played this role in Norway, using researchers from the RCN-funded BigInsight research centre to provide real-time data for policy planning, monitoring the spread of the disease, calculating reproduction numbers at national and local levels, predicting numbers of hospitalisations and providing scenarios to allow the development of vaccination strategies. To do this, NR mainly built on models that were in place before the pandemic. A PhD project that used mobile phone data to help predict the spread of 'flu in Bangladesh already being done by an NR researcher provided a novel way to predict the spread of the disease without waiting to collect additional data from the field. NR was also able to feed models run by the Norwegian Institute for Public Health, and provided data allowing the health service to develop differentiated vaccination strategies for different parts of Norway. The subsequent inquiry into the pandemic (*Koronautvalget*) has confirmed the importance of NR's activities in combating the pandemic. The group has also contributed to the Norwegian Directorate of Health's account of the socio-economic effects of intervention.

UiO Department of Mathematics Sequential Monte Carlo methods for Covid-19 analysis

This research was done by the UiO Department of Mathematics under the umbrella of the BigInsight research centre. Together with the preceding Norwegian Computing Centre case, this forms part of the national COVID effort, coordinated by the Norwegian Institute for Public Health (NIHP). A key part of understanding the epidemiology of the pandemic was to monitor the 'reproduction number', which is the number of additional people who would be infected by a new person falling victim to the disease. Once the reproduction number can be driven below "1", the pandemic will subside. Achieving that depends on many variables such as vaccination, natural immunity in the population, isolations and distancing measures, demographics and so on, so there is a need to understand almost in real time how and where the reproduction number changes in order to plan interventions. The research used Monte Carlo simulation methods to estimate these values in collaboration with the Norwegian Computing Centre and use them in modelling by NIHP and the UiO Institute of Medical Sciences.

These projects, and the overall coordination work at NIPH, provide powerful examples of the ability of the research system quickly to mobilise against a new threat, reducing illness and death and hastening he resumption of normal social and economic life.

UiB Informatics New person-identifier to replace person-number

Since the 1960s, Norwegian citizens and residents have been allocated a unique personal identifier (PID) at birth, that is used to identify them in relation to all interactions with the state. Increases in population, the amount of electronic information held by the state on citizens and the need to keep such information secure meant that a new design was needed for the PID after 2011. Two professors from UiB developed, costed and presented four alternative designs, intended to be robust for use in state information systems up to 2150. Their proposal for which one to adopt was accepted by the government and will be operational from 2032, affecting every resident of Norway.

UiA Engineering and Technology Tsetlin machines

This case provides an alternative approach to AI-based machine learning that is said to avoid the use of the massive amounts of energy needed to run current US AI models. Based on ideas on learning automata and game theory articulated by the Soviet mathematician Mikhail Tsetlin in the 1960s, Tsetlin machines replace energy-intensive deep learning techniques with logic-based machine learning. They are hardware-near, with very low energy and memory requirements. Ole-Christoffer Granmo at UiA introduced the idea of Tsetlin machines in 2018, which are now seen as suitable for addressing a long list of functions in AI, including keyword-spotting, sentiment analysis, novelty detection, game playing, battery-less sensing, and legal analysis. They have triggered the development of energy-harvesting machine-learning solutions at Georgia Tech, and the development of a new generation of AI chips at Newcastle University, offering several orders of magnitude increases in throughput at the same time as several orders of magnitude reduction in energy consumption. A growing number of R&D projects are exploring implementation. At this stage, there is no evidence of societal impact, but the scope for changing the development pathway of learning-based AI appears to be extremely large, with potentially global effects.

UiO Mathematics Ship-driven mini-tsunamis

This case was triggered by a journalist from the Norwegian Broadcasting Corporation, NRK, who was receiving complaints from residents that two particular 30,000-ton ferries were causing ‘mini-tsunamis’ when passing through a narrow sound on their way through the Oslo Fjord, despite proceeding slowly and in line with the relevant navigation regulations. There was damage to boathouses and beaches in the area. A specialist from UiO was initially unable to explain the waves, which appeared ahead of the bow and after the stern. Conventional formulae suggested that the ships were steaming well below the speed that would be needed to cause such waves. After observing and measuring the effect, the researcher further developed his past work on wave production, and discovered that the waves were produced when the ships passed over a shoal, effectively ‘squeezing’ the water out ahead of it as the bow passed over the shoal and the ships rode up, then producing a second wave as the stern passed from the shoal to deeper water. Thus the incident led both to a discovery important to navigation in shallow and narrow waters and to the ships’ captains taking a different course to avoid the shoal. After this, there were no more mini-tsunamis.

HVL Ballast water treatment

This case also involved UiB, NORCE and the Norwegian Institute for Water Research (NIVA)

Steel ships use ballast water to gain stability and trim the vessel so it can manoeuvre when it is carrying little or no cargo. This can involve taking on water (and sea life) in one part of the world and then discharging it in another – along with sometimes toxic or invasive species such as zebra mussels, sea lampreys, caulerpa taxifolia (a toxic seaweed), and various phytoplankton and zooplankton. The International Maritime Organisation established a convention in 2014 requiring all ships in international waters to have ballast water treatment systems by 2017, to prevent the transport of sea life in ballast water. The Norwegian Knutsen shipping group developed a ballast water treatment system (KBAL) based on irradiating the water with UV light, which it has installed in its own fleet and sells to other shipowners and shipbuilders. HVL has done several projects on ballast water analysis and treatment, some of them in collaboration with Knutsen, since 2011, establishing a *de facto* standard organism for testing treatment systems, improving measurement techniques, testing the efficacy of UV treatment, this supporting the type-approval of KBAL by the International Maritime Organisation and the US Coast Guard (which uses different standards for the effectiveness of ballast water treatment). HVL has thus contributed to mitigating the worldwide threats posed by ballast water and supported an important innovation by a Norwegian firm that is now sold worldwide.

NTNU Electronic Systems Autonomous ferries

This case also involves NTNU Departments of Engineering Cybernetics, Marine Technology, and Design.

NTNU hosted a Centre for Autonomous Marine Operations and Systems from 2013-2023. An initial project was a 5-metre autonomous ferry “Milliampere 1” launched in 2017, which served as a development and test platform for masters students and PhD candidates working with autonomous systems. It was followed in 2019 by “Milliampere 2”, an 8-metre autonomous passenger ferry certified for transporting 12 passengers. With the help of the FORNY technology transfer programme, the Zeabus company was then spun off, which employed 28 people at the time the EVALMIT self-assessment report was written, turning over $3.1m in 2023. A 25-passenger, solar-powered autonomous ferry “Estelle” using the Zeabuz software entered Summer service in Stockholm in 2023. At this early stage, the commercial activities are experimental, but there seems to be considerable potential for future growth, especially if more mainstream business interests are attracted.

SINTEF Ocean Offshore wind

SINTEF has a long history of working with offshore structures, from ships through oil and gas exploration and exploitation to, more recently, offshore wind. SINTEF Ocean has over the years built tools for simulating and testing offshore structures in a variety of joint projects, industry projects and as part of the NOWITECH research consortium on sub-sea structures. It has developed a software package called SIMA, which is able to handle both fixed and floating structures, which are subject to complex interacting forces. Since 2013, SIMA has been distributed by DNV and been applied in about 70 companies worldwide, generating about NOK 8-10m per year in licence fees to SINTEF. Users include: Equinor (formerly Statoil), which is a leading player in offshore wind and part-financed the development of SMA: COWI, a Danish engineering company heavily involved in designing foundations for offshore wind; Taisei, which has used SIMA and Sesam in floating offshore wind designs; and Saltec Offshore Technologies designing floating wind foundations. Floating offshore wind is likely to be especially important for Norway, which largely lacks a shallow continental shelf. SINTEF Ocean has therefore played a role in enabling offshore fixed and floating wind farms to be built in many parts of the world.

7. Conclusions and recommendations

The evidence presented in this report suggests that Norwegian research in MIT fields is broadly healthy and very relevant to current national needs. This Chapter identifies five areas for improvement and recommends actions at the levels of the research-performing organisations, RCN and the Ministry needed in order to address them.

7.1. Conclusions

Norway has a strong research system, given its small population, which has co-evolved over a long period with industry and society. The system reflects the need for applied research to support national industries, many of which are not R&D intensive but whose performance nonetheless depends on understanding and exploiting the technological state of the art. The system has to generate and communicate new industry-relevant knowledge in specific areas of need, support industry's ability to absorb and exploit technological opportunities, proactively enter and build capacity in new fields needed to maintain competitiveness, and support industrial restructuring and renewal. The MIT fields are central to this. They comprise a large part of the Norwegian research effort, accounting for over 40% of RCN funding for research and the greater part of Norway's research income from the EU Framework Programme.

On average, university research expenditure is about 80% paid for from institutional funding for research, giving some freedom to change research directions in response to advances in science and changes in society. The institutes' low level of institutional funding (11%) forces them to keep their applied work very close to customer needs. The extraordinary concentration of research effort at NTNU and SINTEF demonstrates the power of close relations between universities and institutes.

MIT research in Norway

The three major field of research considered in EVALMIT are Mathematics, ICT and Technology.

Pure mathematics has a long tradition in Norway, with the strongest groups being in the older universities, notably UiO, NTNU and to a lesser degree UiB. Mission-orientated organisations including SINTEF and Simula are more important and drive societal impact in applied mathematics, though UiO, NTNU and UiB also play important roles. In statistics, too, the leading research groups are at UiO, NTNU and UiB.

ICT comprises many sub-fields and is important to many different parts of industry, with SINTEF and NTNU often taking leading roles in research. UiO does little research in ICT by comparison, given its traditional focus on natural science more than technology, but its informatics research is very large and of high quality. There are many strong research groups, some in the newer and smaller universities that have grown up in the last few decades during which ICT has built up to its current social and economic importance. These groups tend to be rather scattered across the ICT sub-fields – while ICT is very important across the Norwegian economy – partly because there is not a strong cluster of ICT companies in Norway whose influence would encourage the formation of academic clusters in related topics.

'Technology' covers a range of sub-fields at least as broad as ICT, but its specialisations are more clearly defined by their high relevance to longer-standing branches of industry, notably marine, energy, oil & gas and construction. NTNU and SINTEF are the leading research performers in most parts of technology, though this is true to a lesser degree in oil technology. As in ICT, the development of newer industry has provided more opportunities for newer colleges and universities.

Comparative bibliometric indicators for scientific articles that include Norwegian authors at the level of broad fields of MIT suggest that citation of research papers in Mathematics is marginally below the world average, Marine Technology is just above the world average, while ICT, Energy Technology and Other Technologies are comfortably some 15-20% above average. A lot of the effort and publications in Norwegian research are clustered in in nationally relevant sub-fields, where citation rates are substantially higher than in sub-fields in which Norway does not specialise. More generally, Norwegian MIT citation rates tend to be higher in applied sub-fields than in more fundamental or theoretical ones. The bibliometric analyses also suggest there are some sub-fields such as pure mathematics, statistics and probability, and technology fields important to the green transition such as decarbonisation of oil & gas and green energy, where publication citation levels are low in international comparison and might therefore need to be strengthened to meet scientific and national needs.

Characteristics of research in MIT

The EVALMIT national committee has identified several characteristics of successful MIT research, which are consistent across all the MIT fields, presumably because of their applied, industrial nature.

Differences in research group performance appear to be more driven by context and behaviour than by field or discipline. Successful groups are generally larger than unsuccessful ones, have critical mass and do research whose quality is high or at least adequate to their context. Unsurprisingly, since Norwegian MIT research is generally applied, successful groups have close contacts with industry and other societal users of their competence. Hence, knowledge about needs helps shape their research agendas, focusing their efforts on providing solutions to problems that have a good probability of being adopted and therefore creating societal impact.

Successful groups have strategies based on a combination of demand-side understanding and wider knowledge about advances in research and the technological frontier. Relevant demand may be situated at the regional level – it is not always necessary to connect to a national set of users. Strategies need to be formed at the research group level, where the understanding of the demand side is located. Some departmental or organisational strategies are too high-level to be effective, trying to span multiple research areas and societal needs but failing to be specific enough to be useful. Given the applied nature of Norwegian research in MIT, successful approaches are often interdisciplinary, opening the door to new fields of research.

Successful research groups tend to be members of international networks, bringing them into contact with global rather than only national research communities and developments. This requires a degree of short- as well as longer-term researcher mobility, and can often be supported by participating in the EU Framework Programmes. Contact with international research communities is crucial because *de facto* research quality standards are set at the global level. The successful research groups also tend to have ambitious publication strategies, aiming to be visible in high-status journals and conferences, disseminating their ideas and implying to the wider community that they would make promising research partners. The internal structure of research groups is also a key to success. They often need to have more junior researchers – especially PhD candidates – than at present to 'leverage' the expertise of the professors, making research efficient and making it easier to enter new and expanding research fields. Many of the more successful research groups have higher-than-average ratios of PhD candidates to professors.

Much of the very successful research is done at traditional universities and SINTEF. Less successful research tends to lack some of the characteristics listed above. Often this is done by smaller groups and in smaller institutions, or in departments that had been absorbed into larger universities in recent years and not yet fully integrated. Their small scale and comparatively limited resources prevent them from overcoming the entry barriers created by the success of other groups. One important problem (which, in fairness, is also shared by some of the bigger groups) is weak capacity for designing and deploying research strategies. These strategies are often vague or overly bottom-up, sometimes reflecting what individual researchers want to do but lacking a clear direction for the research group and therefore failing to define specific research foci and marshalling research resources against them. This in turn makes it difficult to change research direction, for example to address directly problems relating to the societal challenges. A frequent problem for these weaker research performers is that they have not yet been able to integrate into global or European research networks, which would let them access both leading ideas and issues in science and extend their relationships with industry.

An issue the Committee identified across almost the whole of MIT research was a lack of sufficient fundamental research, presumably as a result of short-term pressures to produce deployable results. This was especially an issue in Mathematics, where researchers found it particularly difficult to fund small theoretical research projects, owing to the low success rate for bottom-up proposals at RCN. This threatened in the longer term to undermine the ability of research groups to support industrial development and renewal, as well as to continue to do dynamic work. Similar to Mathematics, ICT and Technology clearly would benefit from enhancing fundamental research as required in their individual themes. However, it is worth noting that Applied Mathematics, ICT and Technology all depend heavily on applying ideas from pure mathematics, and so the Norwegian MIT community as a whole would benefit from strengthening fundamental research in mathematics.

Societal impact

The administrative units submitted to EVALMIT assembled an impressive set of impact case studies, though the clarity of communication was variable and in some cases there was only limited concrete evidence offered of impact. Some of the most powerful cases came from the institutes, building on long-term relationships with industry that equip them with a deep understanding of the industrial context and its needs. Some university groups have similar relationships, but by no means all do. Many of the impacts documented took place across disciplinary and industry boundaries. Where spin-offs took place (which is in a small minority of cases), they tended to appear in clusters over a period, reflecting the research groups' strong understanding of the demand side. They therefore tend to address established industry, rather than getting involved in new branches.

The wider research context in Norwegian MIT

The context for MIT research in Norway contains both challenges and opportunities.

Researchers in Norwegian MIT generally enjoy good working conditions and benefit from a high level of research infrastructure. The strength of the infrastructure makes Norwegian researchers attractive collaboration partners in the EU Framework Programme and other international collaborations. PhD candidates appear to be well served in larger research groups and administrative units with the scale to organise shared doctoral education and to maintain a group of several candidates. Some of the smaller administrative units in newer universities were too small for this, leaving PhD students isolated.

The great majority of publications are now available in open access. While all the administrative units have data curation policies based on FAIR principles, there are no statistics available that can confirm the extent to which these principles have been implemented.

Large numbers of senior professors will be retiring in the next few years, presenting not only promotion opportunities but also options to change research direction by hiring professors with different specialisations or reallocating resources to building new capacity among mid-career people.

Student and faculty recruitment is generally difficult in Norwegian STEM subjects, including MIT. As a result, the proportion of foreign-born students and faculty members is rising,

The Norwegian system carefully monitors researchers' gender. The gender gap in Norwegian MIT research continues to close at a slow rate, but does not appear to be worse than in other countries generally. However, other kinds of diversity – notably race, national origin – appear not to be monitored.

While the close relationship between research and industry in many MIT fields strongly supports industrial competitiveness in periods of incremental technical change, it also encourages path dependency by reducing incentives for change in research. This has been identified as an issue in RCN research programmes in the past (Narula, 2000) and also at the level of the emergence of new fields such as 'omics' in the 1990s and ICT in the 2000s (Arnold, et al., 2001; Arnold & Mahieu, 2012), new developments in materials, 3D microprinting and laser processing in the evaluations of Technology research (Rauch, et al., 2015). Currently, there may be similar issues in relation to AI and quantum computing. Such inflexibility needs to be addressed at both the micro level of improving research groups' horizon-scanning and strategy processes and at the macro level of creating funding programmes and other policies that can exert clear directionality.

The committee notes that the current geopolitical and security situation involves challenges for both scientific and industrial cooperation, both of which have in recent years been regarded as normal and desirable, but regards any recommendations on this subject to beyond its scope.

Results in the light of the previous evaluations

Compared with the evaluations of the MIT fields some ten years ago, the committee finds that

- As might be expected of a small country, MIT research is often internationally excellent in terms of originality significance and rigour but is still only in rare cases world-leading
- The research institutes – notably SINTEF, but also others – continue to play pivotal roles in supporting industry and development
- Research strategies are often still 'looser' than might be optimal, and among weaker research groups would benefit from being more closely coupled to industrial needs
- While the research system continues to support existing industrial needs, it remains insufficiently proactive and slow to get into new areas – currently, such as aspects of the green transition, AI, and quantum computing
- Tight coupling to current industrial needs means research is insufficiently coupled to the needs of 'unborn industry'
- The systemic role and value of fostering newer and smaller research-performing universities and colleges remains insufficiently clear

7.2. Recommendations

The conclusion that the MIT research system in Norway does well at supporting current needs has the corollary that action should be taken to improve its ability to cope with and exploit change. The needed actions are in five areas, some of which need tackling at more than one level.

First, whether the focus is on the societal challenges identified in the EU Framework Programme some years ago or on the newer 'multi-crisis' of rapidly-changing geopolitical, security and defence, resilience, and climate change adaptation, it is clear that the research and innovation system needs to move beyond slowly and comfortably adapting to incremental changes as it has done in the last few decades and towards more flexibly and rapidly tackling more radical change needs.

- Research performers need to consider how to develop more dynamic and flexible ways to modify their thematic priorities and capabilities, developing strategies that encompass their research agendas, industrial links, partnerships, and human resource requirements in ways that are sustainable over time. This will involve delicate judgements, for example about how much resource to reallocate from traditional to new themes, whether to replace retiring professors with specialists in the same or other areas, or to recruit more junior and mid-level researchers better able to build strong research positions in new fields or sub-fields
- Decide whether to use instruments such as funding programmes to support more traditional fields whose research performance falls below par. Based on the analysis in this report, such fields could include pure mathematics, statistics, oil & gas, and green energy engineering
- The research and innovation systems will also need clearer signals and incentives for change from the national policy level through more change- or transition-orientated national programmes for funding and infrastructure development that provide increased directionality, tending to coordinate the national effort

Second, ensure that the foundations in fundamental research of the applied fields discussed in this volume are sufficiently solid. Fundamental research is not only a source of knowledge to be used in applications but also a way to retain national membership in the global 'invisible colleges' (Price, 1963) of researchers that define and address key disciplinary problems, a way to identify medium-and longer-term research priorities, and an important training school for researchers. MIT research performers in Norway therefore need to prioritise fundamental research to a greater extent, without losing sight of the importance of applied research in serving their societal mission. This implies:

- At the level of the research performers, seeking more funding for fundamental research through both national (FRIPRO) and EU (ERC) funding. These bottom-up programmes are among the most competitive schemes available. Norwegian universities have high institutional funding and should also exploit the freedom this brings to do internally funded basic research
- RCN should consider whether its portfolio contains sufficient funding for fundamental and other low-TRL research specifically for applied fields

Third, EVALMIT provides evidence that highlights differences in performance among different groups of research performers. While bigger groups in established organisations often perform well, history, funding, scale and sometimes location stack the odds against researchers in smaller and newer organisations, notwithstanding the fact that some research groups in such organisations nonetheless perform strongly. This resurfaces the question asked (but not answered) by the MIT evaluations of a decade ago about the expected role of such research groups and organisations in the research and innovation system. An effect of the Quality Reform with a unitary set of funding and assessment rules for the higher education system, together with the restructuring of that system in Norway in recent decades, has been to give all institutions incentives to try to become nationally-orientated research universities. It is not clear that this is desirable in terms of either national or regional policy, or that enough resources could be available to make it feasible. While these questions are beyond the scope of a field evaluation such as EVALMIT, there seem to be at least two ways to address the inequalities of resources, scale and performance identified here:

- Ring-fence research funding for the smaller and newer institutions to support further capacity-building. RCN's earlier programme of such funding was abandoned about 20 years ago. It is noteworthy that Sweden's Knowledge Foundation (KK-stiftelsen) has had considerable success using ring-fenced but competitive funding to build research capacity in the equivalent Swedish organisations, and also that this took 30 years
- Establish field-specific research 'pairings' between established and newer organisations to provide mentorship and some shared scale. Swedish experience is that this can be productive, for example linking KTH with Mid-Sweden University in pulp and paper technology and Lund with Blekinge in digital signal processing

Fourth, in the new geopolitical context, it is increasingly important for research groups and organisations to establish and maintain presence in international networks. This provides access to and participation in scientific advance, broadens access to industry from a national to an international level, allows researchers to operate within the circles that define R&D agendas, standards, and norms, and creates alliances to access funding. Norway has privileged access to the EU Framework Programme. Policy measures that support that participation – especially among the research groups that at present have little presence there – would further strengthen MIT research in Norway.

Further action is required on gender balance and on diversity. The findings of EVALMIT here are more or less identical to those of EVALNAT a year earlier, and appear likely to apply across much if not all of the Norwegian landscape

- The MIT fields are well-known internationally for having a particularly strong gender imbalance. While EVALMIT administrative units universally have policy commitments to reducing this imbalance, and clearly aim to use individual appointments to try to reduce it, there are few systematic measures in place, or measures intended to make research a less family-unfriendly place to work
- Wider aspects of diversity appear largely to be unmapped in Norway except at the level of counting the numbers of non-Norwegians employed in research. Other successful research systems – for example, Switzerland and Luxembourg – are heavily reliant on foreigners. Norway should find out more about both the welfare and the research policy implications of the rather sudden shift in the composition of the research community in recent years

Table 15 summarises the committee's recommendations and suggests actions at the level of the research-performing organisations, RCN and the Ministry of Education and Research.

Area	Research-performing organisations	RCN	Ministry
Adopting and adapting to needed changes in research agendas	Launch internal education programmes to increase the capacity of research groups and higher management levels to design and deploy wide-ranging research strategies, spanning both research themes and the associated physical and human resource needed to implement them When professors retire from fields needing change, consider hiring people at earlier career stages and building capacity rather than only making change at the top. There is also scope to use the fact that many academics are passionate about continuing their work after retirement age by creating new post-retirement roles that make use of their expertise without consuming as much budget as full-time academic roles	Investigate on a case-by-case basis needs to support MIT research fields that appear to be underperforming, based on the national importance of the fields to science and industry and the prospects of improving performance	Review with RCN's help and proactively intervene to establish programmes to enable the research system to tackle major changes in science and transition-orientated research needs, aiming to respond to these in a more timely fashion Consider the need for scale when establishing new capacity in highly competitive fields such as AI. Concentrate resources in single centres, where appropriate
Safeguarding the fundamental research foundations of MIT	Modify internal planning and budgeting procedures to create formal ways to allocate institutional budget to fundamental research and incentivise principal investigators to apply to relevant external funding schemes	Explore mechanisms for taking a holistic view of the ratio of fundamental to applied research in relevant portfolios, strengthening opportunities and incentives to apply where necessary Consider increasing the number of small- and mid-sized grants for fundamental research in MIT-related fields, especially the mathematical sciences	
Tackling unequal research performance between old and new institutions in higher education	Identify and implement 'pairings' in specific fields or sub-fields where better-established research-performing institutions mentor newer ones and increase joint scale		Review the implications of current higher education policy for research in the newer and smaller institutions. If appropriate, consider establishing a policy for 'pairings' in higher education research – and potentially more broadly
Increase participation in the EU Framework Programme	Set increased objectives for participation in the Framework programme	Review the effectiveness and efficiency of current measures for stimulating Framework Programme participation. Consider modifications to support smaller and less experienced potential participants from Norwegian research in MIT	
Gender balance and diversity	Mentor and plan career for strong female candidates, starting at the PhD level, international postdoc and possible recruitment. Introduce procedures to tackle 'two-body' problems		Review the effectiveness of policies to reduce gender inequality in MIT research; establish improved monitoring of wider diversity and investigate policy implications of the increased share of non-Norwegians in the MIT and other research communities in Norway

Table 15 Recommendations by area

Appendix 1: The committee's perspectives on sub-fields of MIT

Mathematics

<u>Mathematics: Algebra and algebraic geometry; Geometry and topology; Operator algebra; Cryptography; Mathematic analysis; Logics; Mathematical physics; Mathematics/ICT didactics</u>

Overall, mathematics in Norway is doing very well. Research groups publish in high quality journals, collaborate nationally and internationally and participate in national and international networks. 4 research groups stand out especially: sections 5 (Algebra, Geometry and Topology) and 6 (Several Complex Variable, Logic and Operator Algebras) UiO, and Algebra and Analysis at NTNU. These research groups, located in larger and established institutions, are generally well supported by the institution and administrative units. They publish in top outlets, attract external funding, and work strategically to maintain an agile research agenda (e.g., interdisciplinary research efforts in cryptography at NTNU). Three groups are doing less well. The Functional Analysis group at UiA publishes high quality research but struggles to attract significant external funding. To remedy this, the group review panel recommended that the group broaden its research focus. The analysis group at UiB also struggles with external funding. The ESE group at NTNU received lower scores across all evaluation dimensions. This is a relatively new group that has been given informal research group status. This, in addition to the group's focus on engineering education, which has a different publication culture than the other groups, has resulted in an unfocused strategy and unbalanced publication rate and quality within the group. Common to all 3 groups is their relatively small size which limits their ability to address challenges that the self-assessment and/or group panel reports identified.

All groups pursue activities with strong societal impact, with three notable exceptions. On the positive side, the Algebra group at NTNU excels in view of the listed user-oriented publications and products which are fundamental in several aspects of computer security. Two groups are lagging a bit behind the others in terms of societal impact, pursuing standard activities, but the impression can also be due to some shortcomings of the self-assessment.

Overall, all groups express a concern regarding the support to mathematics research in Norway. Sources for funding for "pure mathematics" is more limited than for more applied or interdisciplinary research groups. Some groups have been able to expand to interdisciplinary research projects, but it is important that top researchers in foundational research are given the resources to maintain top international level and not forced to dilute their research time to out-of-expertise areas. Therefore, foundational research in mathematics depends on the availability of small to medium size grants more than large centre grants.

All groups struggle to attract female researchers, a common problem for research groups in other panels as well. Unclear career paths and difficulty to provide internationally competitive starting packages is a problem.

In addition, most research groups express a concern regarding the drop in student numbers. This is a national problem and all research groups together with schools, municipalities and government agencies must work together to ensure that the pool of mathematical students grows in order to meet the national need for this competence.

Many groups note that students leave academia after their master or PhD. To remedy this loss of talent, it is recommended to work actively with mobility programs for young researchers. International research visits and postdoctoral programs, nationally or international, are key instruments here. All groups need to develop long-term strategies for recruitment.

All groups are recommended to develop strategies for increasing the level of funding, especially international funding, perhaps through more strategic use of mobility programs and increased international and interdisciplinary collaborations.

Groups that maintain static or narrow research agendas miss opportunities to meet societal needs and to obtain external funding. Increased national collaborations between large research groups at the older institutions and smaller/younger groups is recommended.

<u>Applied Mathematics: Applied mathematics; Computational and numerical mathematics; Applied mathematical analysis; PDEs; Optimisation theory; Mathematical modelling; Industrial mathematics; Fluid mechanics; Biomathematics; Scientific computing: HPC</u>

The group evaluation reports highlight the superior performance of mission-driven organisations like SINTEF and SIMULA as compared to universities in research quality and quantity. This is attributed to their focused research mandate and more generous funding. Some university groups (Oslo, Bergen, and NTNU) also perform very well. Several of these groups are performing at a high international level. Smaller institutions generally struggle with funding, attracting talent, and international visibility. Smaller institutions (NORCE, OsloMet, Tromsø) struggle to meet obligations while maintaining high-quality research, indicated by difficulty attracting external funding and limited international visibility.

The large mission-driven organisations (SINTEF and SIMULA) demonstrate strong societal impact due to their resources and focus. Similar observations can be made of the large institutions, i.e., Oslo, NTNU and Bergen. Tromsø is a notable exception among the smaller universities. The challenges among smaller institutions to maintain a timely research profile and visibility, often hinders their societal impact.

Mission-driven organisations and large institutions show strong national and international collaborations and attracts some, sometimes very substantial, external funding. However, even for the established institutions, this is an increasing challenge.

The reports highlight a significant disparity between mission-driven research organisations and many smaller universities. There are concerns raised about resource limitations, competition, and a potential decline in resources for fundamental research at universities. This has the potential negatively to impact research in applied mathematics in the long term. The reports also emphasise the need to address resource constraints, improve internal institutional support, and carefully consider the balance between different research types to ensure the long-term health of the Norwegian research system.

It is suggested to consider a national re-assessment of the balance between fundamental and mission-driven research as a question of particular importance of a domain like applied mathematics which has its own fundamental knowledge core.

<u>Statistics: Statistics and data analysis; Stochastic analysis and risk analysis; Insurance mathematics; Machine learning/Artificial intelligence; Data Science; Data Mining/Big data; Language technology</u>

The research groups within this panel are quite diverse, ranging from basic research in statistics and foundations of AI to bioinformatics and contract research with industry. Most research groups perform quite well across all evaluation dimensions while some struggle in all, or a subset of these.

Four research groups stand out as doing very well. UiO Statistics and Data Science has made a conscientious effort to strengthen its research profile in machine learning and the foundations of AI, building on the competence in the group and growing their research education program. The group has historically been very successful in obtaining large grants from RCN. UiO RAS is a nationally and internationally highly visible research group and has, similarly to UiO Statistics and Data Science, made decisions to expand in new research directions (in sustainability) to meet national and regional needs for competence. UiB Algo produces excellent research and achieves a high level of funding, including ERC. NTNU Statistics has implemented a long-term recruitment strategy to maintain strength in its internationally recognised areas of expertise while also recruiting in areas of growth. Common to all these groups is their agile research agenda and strategic expansion. All groups have been able to maintain a balance between applications, including industry partnerships, and theory, and maintain a good PhD-to-faculty ratio.

Six research groups performed less well in the evaluations. NR-SAND is a research group that depends heavily on funding from the petroleum industry. There is limited opportunity for open academic research. The panel recognised this difficulty and recommended that the group tries to strengthen its ties to academic partners. UiS IMF, UiB I2S, UIB LAI, UiT ASR and UiB ML scored poorly in terms of societal contribution and/or organisation. A common factor for most of these groups was their small size. For small groups, a lack of cohesive research strategy means that resources are spread too thin. Several groups were recommended to develop a more focused research strategy, explore synergies within the research group and with related groups within the same academic unit to consolidate resources better. It is also important that newly established research groups and groups working in interdisciplinary projects develop a clear identity/research profile. If possible, groups should prioritise industry and interdisciplinary collaborations projects where members' contributions match level of recognition/visibility and co-funding.

The size of the groups evaluated in this panel varied widely. The organisational overhead for small groups is considerable and there is also an inbuilt vulnerability when research/teaching/outreach depends on 1-2 individuals. Some groups could benefit from being merged, which might also help identify potential synergies within the administrative units.

All groups maintain activities to generate societal impact. Groups that work closely with regional stakeholders and have been very successful in this regard. Having an active interdisciplinary and international research network is, for the most part, associated with both high quality academic performance and high societal impact. By contrast, some groups are missing an opportunity to work with regional stakeholders on topics of regional interest.

Many groups could benefit from increasing their research education program. This would be especially valuable in AI/ML where you need a large PhD education program to be internationally competitive. Expanding international and interdisciplinary collaboration, including with non-academic partners, may help identify new funding sources and/or increase the probability of obtaining EU funding. Groups could use mobility programs, including MSCA, more strategically to build partnerships with international research groups.

Some groups need to move away from publishing in less visible outlets as this leads to a downward spiral in terms of international recognition. A lack of cohesion, or a lack of focused research agenda, within a research group, risks leading to poor long-term strategies for recruitment and poor use of limited resources. Small groups are vulnerable to staff turnover and drop in funding levels. Increased national collaboration to form strong partnerships between research groups is recommended.

ICT

<u>Cyber/Communications: Cybersecurity; Cryptography; Communication systems; Multimedia and speech processing; Networks; Distributed systems; Internet of things (IoT)</u>

Norwegian research in cybersecurity, Internet-of-Things (IoT), and communications shows notable strengths and areas requiring improvement. SIMULA excels in cryptography research and international collaboration. UiA demonstrates strengths in IoT and mobile communications, while the research at SINTEF in trustworthy green IoT and software benefits from strong infrastructure. Cryptography, cybersecurity, IoT, and mobile communications are strategically important fields of research, driven by significant security challenges in society.

However, several units underperform. The research at UiA in communication and system security lacks clear strategies and evidence of progress. The research at NTNU in smart wireless systems struggles with weak publications and low funding, and the research at UiT faces modest scientific outputs and few PhD students. Middleware research is losing its relevance and impact. Societal impact is uneven, with high-impact units at SIMULA, UiA, and SINTEF contrasted by relatively low-impact units at UiA and OsloMet. There are problems of sparse administrative support, the need for proactive diversity recruitment, and low numbers of PhD students.

Recommendations include enhancing international collaborations, targeting prestigious publication venues, improving dissemination strategies for societal impact, and focusing on emerging technologies like 6G.

VR, image processing, HCI, EO” Virtual reality: Visualization; Visual computing; Image processing/analysis; Human computer interaction; Earth observation

This panel assesses Norwegian research groups in the areas of VR and HCI, highlighting UiB's Visualisation group and UiO's Digital Signal Processing and Image Analysis (DSB) as high performers, particularly in applied research areas like geomatics and HCI. They show excellent publication records and impactful applied research (patents and spinouts). Geomatics, visualisation, and HCI sub-disciplines perform well, particularly in applications rather than methodological research. Less successful groups include NTNU Colourlab and UiT's Centre for Artificial Intelligence (CAI) which underperform in funding and research quality. CAI also faces issues with recruitment, retention, and gender diversity. Several groups lack submissions to top conferences, hindering impact. Methodological research in vision and machine learning struggles, potentially due to publishing in less impactful venues. OsloMet's Universal Design of ICT (UD-ICT) needs support to advance at the university level.

Groups with a high impact include UiO's DSB (medical patents and software), SINTEF's Computer Vision (industry connections), NORCE's DARWIN (marine sector contributions), OsloMet's UD-ICT (public education and events), NTNU's Geomatics, and NR's BAMJO (high societal relevance projects). Groups with low or limited societal impact often lack clear strategies for stakeholder engagement. The report highlights that the split of CAI at UiT's into two groups may negatively impact research quality.

NTNU's Colourlab, SINTEF's HCI group, and UiO's DSB group demonstrate strong collaborations, often linked to successful European funding applications and collaborations. The report flags methodological weakness in certain industrially focused groups, suggesting a need for stronger university collaboration. Groups need to improve self-assessment reporting on societal impact.

The low gender diversity across research groups needs attention, with measurable goals to promote a more inclusive environment. More focused strategies and increased stakeholder engagement are needed to improve societal impact for many research groups. This requires better self-assessment in reporting. Some industrially oriented groups could benefit from stronger collaboration with universities to improve their methodological approach.

Control: Control theory and robotics; Autonomous systems

Norwegian research in control, robotics, autonomous systems, and engineering cybernetics is internationally very strong, with standout contributions from NTNU, which excels in cutting-edge research, advanced facilities, impactful collaborations, and societal contributions in maritime systems and life sciences. Other well-performing areas include the research at SINTEF in maritime ICT and cybernetics, the research at NORCE in air and space observing systems, and the research at UiO in robotics and intelligent systems.

Key challenges include focus, funding, and recognition issues faced by units from former university colleges, including OsloMet and UiA. These units also struggle with recruitment and balancing applied and basic research. Additionally, relatively low external funding and low PhD-to-professor ratios limit competitiveness. Research in industrial robotics lacks Norwegian industrial backing. Research institutes face difficulties maintaining staff and competing for funding due to relatively low basic funding. Norway’s recent investments in AI highlight the need for a strategic focus on applied AI to strengthen research efforts and societal impact. The recommendations are to develop a national strategy to leverage investments and Norway’s strengths in applied AI and autonomous systems research.

IT systems: Digitalisation; Software engineering; Information systems; Programming technology; Reliable systems; Digital systems and organisation; Formal Methods; eLearning

Norwegian research in software engineering, information systems, and programming is very good, with several units achieving excellence in research quality, collaboration, and societal impact. NTNU stands out in software engineering for its focus on empirical research and learning technologies, supported by strong academic and industry networks. SIMULA also stands out in software engineering, benefiting from good funding, and impactful research projects. NTNU excels in information systems through interdisciplinary research, while the research at UiO in information systems has a global impact on health informatics. The research at UiO in reliable systems demonstrates strong international engagement and a clear, strategic focus across fields like engineering, health, and biology.

There are challenges within the underperforming units. The research at UiB in programming theory is too inward-focused, with low research output and societal impact. The research at UiA in integrated emergency management struggles with a lack of strategic direction and adequate funding. The research at USN in digital information systems faces organisational issues across campuses, unclear strategies, and limited publication ambitions.

The top-performing groups demonstrate that strong collaborations and networks are crucial for success, while weaker groups lack these elements. Broader trends reveal challenges in recruitment, retention, and diversity, as well as inconsistent self-assessments and missed opportunities to align with evolving scientific and societal needs.

Micro and nanotechnology, sensors et.al.: Micro and nanotechnology; Materials technology (incl. solar); Sensor technology, Medical ICT; Signal processing

The ICT research topics reviewed in sub-field 8 are quite diverse, in that although their individual origins are clearly at the forefront of science and engineering, their commonalities are not straightforward to identify and use for characterisation of the sub-field, incl. comparisons with global standards. This may prompt alternative approaches to taxonomy in future RCN research assessment exercises.

Across the three Dimensions, The Organisational Dimension yields weaker results, but not substantially so, as the spread between the three is small.

The groups in the academic sector are performing overall better than those in institutes. This is most prominent in the Quality Dimension, combining publications quality and group’s contribution. At the same time, in the Societal Impact Dimension (contribution and user involvement), groups in Institutes are doing marginally better than academic groups. This can be interpreted with a reference to the criteria used: academic groups typically have better publication records, while the funding model in institutes results in higher societal impact through industrial pull. This does not appear as a substantial discrepancy though, given that typically good ties and collaborations exist between Universities and Institutes, particularly where they are co-located.

By large, the research strategy of the individual research groups is clearly in line with the organisation. Overall, for most of the groups evaluated in sub-field 8, work on adopting measurable milestones to be used for judging success more precisely, will help to improve the quality of strategic planning.

AI and data science: Applied AI and data science; Industrial applications; Information technology; Innovation; Entrepreneurship; Digital transformation

The evaluation of research groups in the domains of AI and Data Science reveals that the University of Oslo's Digital Innovation group (DIN) is a top performer, excelling in research quality and societal impact due to its strong structure and diverse contributions. Several SINTEF groups (Smart Data, Software Product Innovation, Digital Process Innovation, and Digital Production) also demonstrated high quality, characterized by strong funding, diverse projects, and focus on relevant research issues. The University of Oslo's Entrepreneurship (ENT) group also showed high publication quality despite limited external funding.

Weaker groups, often from smaller universities such as Kristiania University College (IDEAS Lab and BT Lab) and the University of South-Eastern Norway (ACSAD), received low scores due to a heavy focus on teaching, an ongoing struggle to attract external funding, and weak organisational support. This leads to lower research output and societal impact.

Top-performing groups demonstrated significant societal impact largely due to strong collaborations with industry and public organisations. Impact varies from direct contributions (patents, software) to indirect contributions (policy guidelines, process improvements). Groups with low societal impact typically lacks collaborations with external partners and a detailed strategies for engagement.

High-performing groups shows strong organisational structures, a diversified project portfolio, and robust collaborations (industry, public, international) while groups with limited impact are characterised by a lack of organisational support, external funding, and effective collaboration strategies.

Overall, the weaker institutions will require stronger support, both at the local administrative level as through collaborations, be it with national or international partners. While a problem-solving focus is valuable, some groups should consider a more ambitious publication strategy to increase visibility and funding opportunities. Vague or inconsistently used benchmarks in self-assessments require improvement for more effective evaluation.

There are concerns about gender balance across the general domain.

Technology

Green Energy : Renewable energy production (hydropower, wind power, solar energy and bioenergy); Energy system; Energy efficiency; Energy transition, Thermal energy storage; Batteries and hydrogen production

Research is internationally excellent in areas such as Power systems and Energy systems, Offshore energy systems, Thin film and membrane technology and Hydrogen technology. There is a strong correlation between research excellence and societal impact and strong impact also in these areas. Overall the topics addressed by the research groups are well aligned with international trends and with societal needs and research is creating societal impact. However, there are several examples where the research groups try to cover too broad scope leading to loss of critical mass to really be internationally competitive. This is also reflected in the lack of clear research strategy to reach a high international level, and for collaborations and impact, and rather reflects that the groups do not have specific goals and objectives. As a result most groups are doing rather well but are not internationally excellent. However, in many cases there is potential for taking the next step, but this requires focusing and strategic cohesion within the research group and might be something that needs to be better imposed by the host institution.

Marine Engineering: Marine and ocean technology; Ship design; Hydrodynamics; Marin structural design and production technology; Ship machinery and propulsion; System engineering

Norwegian research is generally strong in marine technology/ocean engineering. A significant level of funding is available which results in a lot of high-quality work, as reflected in the high-quality research carried out at NTNU and SINTEF. Research is very strong in oil and gas (O&G) related areas, with many research projects and publications. Ship-related research areas like sustainability and optimisation of vessel performance are also well covered, and emerging areas, including new technologies to enhance the storage and transport of new fuels (e.g. hydrogen, ammonia and CO2) as well as the use of offshore renewable energy in producing sustainable oil and gas are explored by some research units (SINTEF, NTNU). Designing oil and gas platforms, offshore renewable energy structures, and ships for harsh environments; hydrodynamic and reliability-based strength and fatigue analysis are the main areas of expertise of the research groups evaluated. Newer research groups at HVL and USN generally have less strong research activity, but they are seeking support for research from their local industries in their niche areas. Research groups could consider longer-term diversification in emerging areas, such as marine and offshore related research in the areas of artificial intelligence and machine learning. O&G companies provide significant support for these RGs, this should be directed towards supporting new and emerging research areas, eg low carbon shipping and sustainability, offshore renewables.

Industrial Technology: Industrial technologies; Circuit design; Acoustics; Electro-technical subjects; Industry, product, and component design; Cyber-physical Systems

The Norwegian research in information engineering, power engineering, and production engineering is, in general, of very good international quality. NTNU generally leads in terms of research quality, with significant international impact, while SINTEF excels in more applied research. UiS and UiT perform well within their national networks. NTNU's research in acoustics and electrical power engineering, along with SINTEF's research in electrical systems, stand out due to their high expertise and unique shared infrastructures. The research in information engineering and power engineering thrives, driven by global challenges like green energy. Units with strong industrial collaborations excel through partnerships with industries like oil, gas, and transportation.

There are some structural inefficiencies, such as overlapping activities and high teaching loads. Strategic planning is overall weak, though SINTEF and UiT demonstrate effective organisation. Addressing these challenges through better resource use and clear strategies could further enhance research quality and impact.

Engineering technology: ngineering technology; Technical geosciences and engineering geology; Applied mechanics; Heat and energy transport; Energy storage; Energy and process technology

Within the panel 11, the thematic fields of the research groups are very broad and their size, characteristics, challenges and potentials vary substantially. For this reason, it is difficult to perform a direct comparison between the groups or to draw a general and unique funding scheme able to optimise the behaviour of all the research groups. Some groups from NTNU lead in terms of organisation and research quality, followed by other groups from SINTEF. Some of them are active at an international level attracting competitive grants for European cutting-edge research.

All research groups are covering research field of strategic relevance and importance for the development of Norway, incorporating the specific Norwegian environmental conditions and requirements. Within these respective field of research, they have performed well and on a high international level. The infrastructure and equipment are generally modern and build a good research basis. Recently significant relevant collaborative research infrastructure has been built up. On the other hand, international collaboration with industry and academia is pursued only to a limited extent and the number of PhD students is rather low, compared to scientific staff number and to some international standards. On the organisational side, several research groups were lacking a clear and cohesive strategy as well as mechanisms for strategic development and quantitative benchmarks. When strategy is derived from the departmental level, it is usually too broad and unfocused.

Since the Panel's components have a very good social impact, this could be exploited to better communicate the main scientific issues and challenges, to attract more students and women, actually lacking. All research groups have established substantial collaborations with national partners from both academia and industry; this expertise and know-how can be used to extend the same activity internationally.

In a global research framework continuously evolving, adaptation to the new and emerging themes requires re-evaluation of the organisation, structure and governance of the research groups, together with time and resources. The current trend towards interdisciplinarity and applied research can reduce the funding schemes available for low TRL-level (basic) research, draining the pipeline for future innovations. A robust strategy addressing this issue is necessary.

Construction: Structural engineering; Building and construction engineering; Building materials; Construction processes and digitalization; Building physics; Concrete; Water and wastewater systems engineering; Energy efficiency in buildings and areas; Climate adaptation of buildings and infrastructure

The groups of panel 12 are, overall, of good international quality. NTNU and SINTEF generally lead in terms of research quality, with significant international impact. IuT, UiA and OsloMet follow with a good national quality, since they are either regional or relatively young, with comparably lower research funding. All research groups are generally stronger in the organisational and research quality dimensions than in the societal impact dimension, or they are not able to clearly express their societal impact.

The best-performing groups most with high publication quality have critical mass in term of staff and research funding, and conduct research in relatively focused fields. Overall, there is a good link between the groups and external industrial partners, allowing the activation of a number of industrial grants, though the latter is not homogeneous among the groups.

Most of the groups show a moderate social impact or sub-optimal communication skills, even though the topics of this area can have a fundamental impact. Groups coming from younger or regional institutions conduct research with a primarily national focus which generally makes research excellence harder to reach, especially at the international level. The number of PhD students of is rather low in international comparison. The strategy of most of the groups could be defined as "mainly reactive" to the external inputs coming from administrative entities of higher level and from the scientific community. A pro-active evolution could be beneficial.

The research groups from younger Universities are more flexible and they could quickly embrace the emerging trends and topics without the constraints of more consolidated groups. Digitalisation and sustainability are critical emerging topics of this panel, which perfectly align with the global issues of digital and green transitions. There are still plenty of opportunities to excel at international level. Individual competences can be systemised through increased interdisciplinary collaboration and the a more intense use of shared national research infrastructures.

In order to understand and exploit the global trend to move towards new themes such as digitalisation, circularity and sustainability and how they can be applied in each specific field (including teaching), the groups should work more at international level and with an international perspective. National policies have changed the funding schemes for Universities, introducing potential problems to groups without a strong link with external national or international funding. A proper strategy can help address this issue. The staff reduction could increase the teaching burden, leaving the researchers with too little time and energy for research; a reorganisation could help in this respect.

Oil Technology: Petroleum technology; Drilling and well technology; Reservoir technology; Basin geology; Multiphase separation and -transport (oil/gas); Processing; CO2 capture, transport and storage (CCS); Geothermal energy

The groups of panel 14 are, overall, of medium international quality. The researchers' tendency is to undersell their research, with more focus on technical publications. Some groups from SINTEF lead in terms of research quality and organisation, while others perform less well. UiS is the worst performing group, probably because it is deeply involved in teaching. Even though the topics covered by this panel are critical for the Norwegian society, on average, the impact is only medium or they are not able to clearly express their societal impact.

Since there is an actual strong research need in this area at a national level, due to the presence of important oil and gas resources still to be exploited, many opportunities can be found. To date, important funding is available for the groups of this panel coming mainly from national industries.

Availability of plenty of National grants and industrial collaboration limit the number of high-quality publications and the international comparison. For the same reason, international grants have low attractivity and few groups only seem to have an internationalisation strategy, almost incidentally. Most of the RGs lacks a strategy that goes beyond the exclusive theme of oil and gas to include other, more topical, future-oriented themes, always linked to the world of energy. As in many other panels, the number of PhD students of is rather low in international comparison. Most of the groups show limited succession planning, together with a gender imbalance.

The presence of a large number of oil & gas infrastructures with and for which new, more sustainable and efficient decommissioning and recovery technologies can be developed constitute an opportunity the could be exploited. At the same time, the actual availability of good level of funds and stakeholders could allow to start developing the technologies for the energy transition. The International arena is an available source for finding useful and effective benchmarks to improve the quality and future-proof the groups of the panel.

It is not clear how well set up the RGs are to cope with diversifying funding sources for future financial stability. The presence of strong national funding perhaps are not incentivising this as much. The continued strong demand for oil & gas engineers risks weakening or preventing the development of long-term strategic thinking, including in terms of training and demand for new skills and talent.

Appendix 2: Additional bibliometric and statistical information

The data in this Appendix come from Aksnes & Karlstrøm, (2025).

MIT overall

NTNU and UiO dominate publication numbers in MIT from the university sector, while SINTEF does so in the institute sector. Overall, the NTNU-SINTEF dyad accounts for 40% of the publication activity on which Table 16 is based.

Sector	Institution/institute	Number of publications	Modified author shares	Share mod. author shares
Higher education sector	**NTNU**	**2121**	**1476.2**	**35.1%**
	UiO	557	352.2	8.4%
	UiA	372	257.1	6.1%
	UiS	300	203.9	4.9%
	UiT	288	188.6	4.5%
	UiB	287	187.3	4.5%
	HVL	251	153.4	3.6%
	USN	200	152.7	3.6%
	OsloMet	205	128.9	3.1%
	NMBU	147	90.9	2.2%
	Østfold	88	57.4	1.4%
	Other units	264	161.0	3.8%
Research Institutes	**SINTEF**	314	199.8	4.8%
	SINTEF Energy	178	112.7	2.7%
	SINTEF Ocean	92	56.3	1.3%
	NORCE	90	53.2	1.3%
	Other units	496	297.0	7.1%

Table 16 Norwegian organisations with the largest MIT publication output in 2022

Mathematics

Norwegian publication output in mathematics is dominated by NTNU, UiO, and to a lesser degree UiB Table 17). As would be expected of organisations focusing on applied research, the institute sector produces a smaller share of the publications in mathematics than it does in other fields. Pure and applied mathematics, statistics and probability, and mechanics provide more than half the publications with the balance coming from other fields to which mathematics contributes.

Mathematicians' publication behaviour tends to some extent to differ from the kind of behaviour seen in the natural and applied sciences. Peer review in mathematics can be very onerous and time-consuming, so some mathematicians prefer alternative publication mechanisms, sometimes including social media. Applied mathematics plays an important role in science and the economy more widely, so mathematicians often publish in non-mathematical journals (as

implies). Hence, comparing raw publication numbers for mathematics and other disciplines can be misleading, However, **within** mathematics, we can expect publication behaviour to be fairly homogeneous (since it reflects the norms and behaviour of the mathematical community).

While the MNCS for the whole of Norwegian mathematics averages 111 over the evaluation period, 2013-2021, there is a clear declining trend between 2013, when the MNCS was almost 120, to 2020, when it had fallen to the low 90s (i.e. below the world mean of 100).

NIFU's analysis of mathematics publications in 2019-2022 shows that Norway is most specialised in pure and applied mathematics and that their citation scores are just below the world average, while statistics and probability scores low. Publications in some of the applications of mathematics (bottom-right in the Figure) are better cited, though those in others are not. Such averaged citation statistics do not capture individual points of research excellence, but give an impression that mathematics is mainly used instrumentally in Norway rather than mathematical excellence driving advances in other fields.

Sector	Institution/institute	Number of publications	Modified author shares	Share mod. author shares
Higher education sector	**NTNU**	206	145.4	28.2%
	UiO	149	104.9	20.4%
	UiB	75	50.0	9.7%
	UiA	45	33.5	6.5%
	UiT	45	31.3	6.1%
	UiS	28	19.0	3.7%
	OsloMet	22	17.7	3.4%
	HVL	23	17.0	3.3%
	NMBU	22	16.0	3.1%
	Østfold	14	11.8	2.3%
	NHH	10	6.3	1.2%
	Nord University	10	6.0	1.2%
	Other units	23	17.7	3.5%
Research Institutes	**NORCE**	12	7.4	1.4%
	SINTEF	10	7.2	1.4%
	Other units	36	22.0	4.3%

Table 17 Mathematics: Institutions/Institutes with the largest publication outputs, by sector, 2022

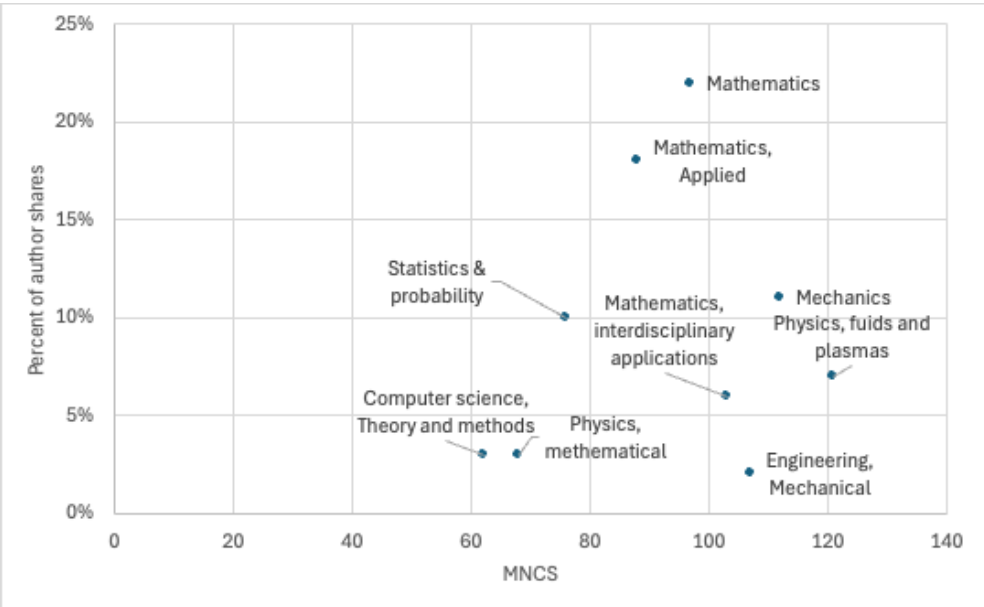

Figure 8 Proportions of article production and MNCS, Norwegian Mathematics publications, 2019-2022

ICT

ICT publication output is dominated by NTNU and UiO, but some of the newer universities (together with UiB and UiT) are medium-sized contributors (Table 18). Published output is mainly in electrical and electronic engineering and in computer science.

Like mathematicians, ICT researchers' publication behaviour also differs from practice in natural sciences, placing heavy reliance on conferences. This has for a long time been recognised by the bibliographic databases such as the Web of Science and Scopus, which these days have a good coverage of international, peer-reviewed conference series such as those of the IEEE. ICT researchers also increasingly publish in software, which is not captured in the databases. Given reasonably homogeneous publication behaviour among ICT researchers and subject to the usual disclaimers, bibliometric indicators can be used to compare citation performance within ICT.

The MNCS for the whole of Norwegian ICT averaged 118 over the period 2013-2022, but was generally below this level in 2013-2017, and above it in subsequent years. MNCS for the various ICT sub-fields suggest Norway does much better in applied and interdisciplinary research than in fundamental work but also that there is a fairly broad set of expertise available within the research and innovation system (Table 18).

Sector	Institution/institute	Number of publications	Modified author shares	Share mod. author shares
Higher education sector	**NTNU**	683	498.8	30.6%
	UiO	270	171.5	10.5%
	UiA	193	132.2	8.1%
	UiB	159	105.5	6.5%
	HVL	154	92.1	5.7%
	UiT	112	75.5	4.6%
	OsloMet	106	61.8	3.8%
	USN	75	56.0	3.4%
	UiS	76	52.5	3.2%
	Østfold	52	33.8	2.1%
	Kristiania	47	29.1	1.8%
	NMBU	29	19.8	1.2%
	Other units	78	46.6	2.9%
Research Institutes	**SINTEF**	134	87.8	5.4%
	NR	34	25.2	1.5%
	Other units	158	94.3	5.8%

Table 18 ICT: Institutions/Institutes with the largest publication outputs, by sector, 2022

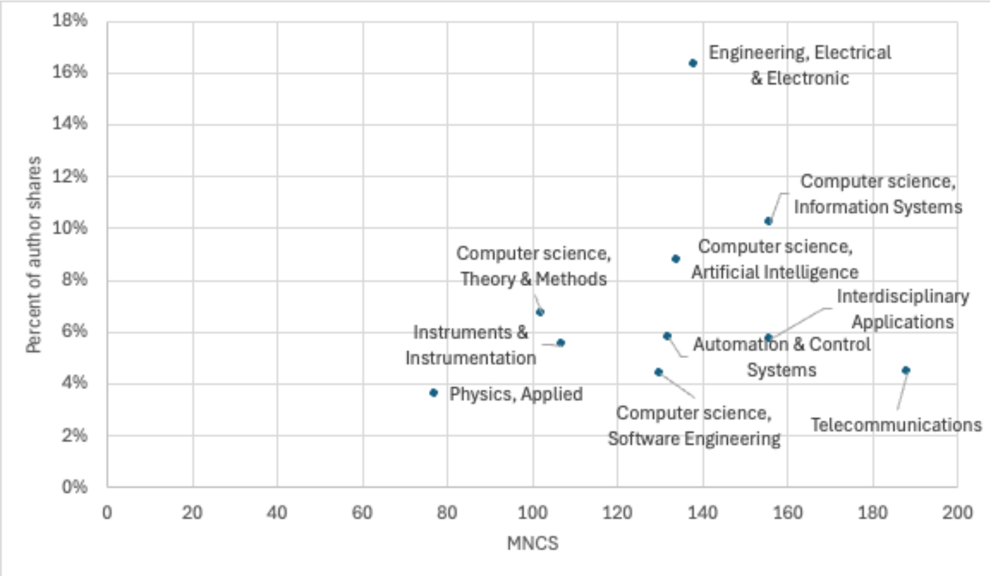

Figure 9 Proportions of article production and MNCS, Norwegian ICT publications, 2019-2022

<u>Technology – Energy</u>

NTNU is by far the biggest producer of scientific publications in energy technology. The NTNU-SINTEF dyad produces almost two thirds (65%) of Norwegian author shares in the area.

By far the greatest proportion of the publications produced relate to energy and fuels (Figure 7). The MNCS for energy technology publications averaged 158 over the period 2013-21. On an annual basis, the MNCS dropped abruptly from above 150 in 2013-17 to around 110-115 in 2018-2021. NIFU suggests the earlier high NCS values were caused by the publication of a set of very strong and highly cited papers in the first half of the decade, with the implication that an MNCS in the range 110-115 is more typical of the community's current performance than the higher level seen in the first half of the period. Nonetheless, Norwegian research is present and well-cited in many energy sub-disciplines.

Sector	NTNU	Number of publications	Modified author shares	Share mod. author shares
Higher education sector	**NTNU**	247	166.8	40.1%
	UiS	40	27.4	6.6%
	UiAr	35	22.9	5.5%
	UiT	23	14.5	3.5%
	HVL	27	12.5	3.0%
	NMBU	16	10.7	2.6%
	UiO	20	10.0	2.4%
	UiB	12	8.0	1.9%
	USN	12	6.0	1.4%
	Other units	14	6.7	1.6%
Research Institutes	**SINTEF Energy**	99	63.4	15.2%
	SINTEF	49	29.3	7.0%
	IFE	22	10.9	2.6%
	SINTEF Ocean	16	9.7	2.3%
	NORCE	14	8.4	2.0%
	Other units	15	8.4	2.0%

Table 19 Norwegian organisations with the largest Energy Technology publication output in 2022

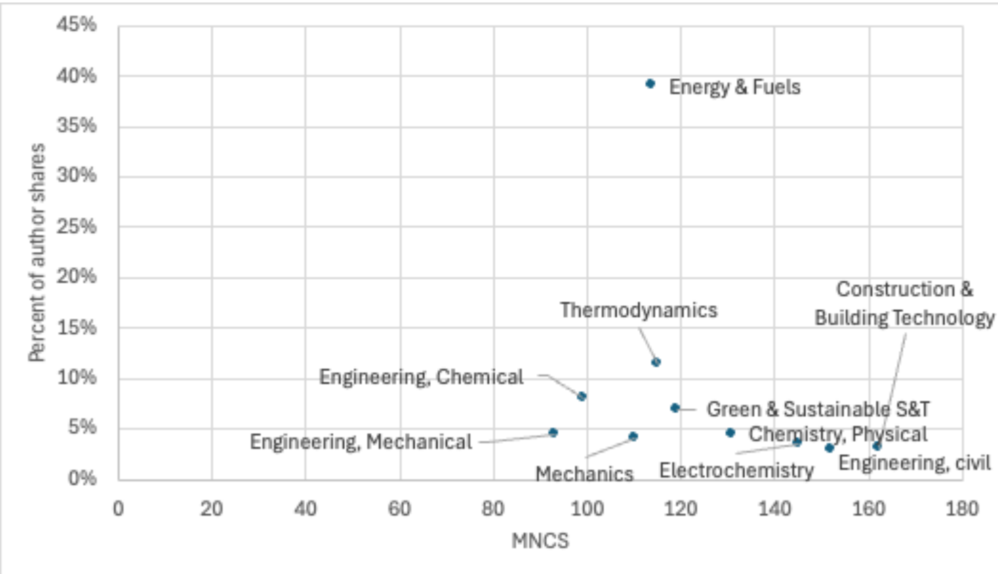

Figure 10 Proportion of article production and MNCS, Norwegian Energy publications, 2019-2022

Technology: Marine Engineering

Marine engineering is an area of traditional strength in Norwegian industry and research. As in energy research, NTNU-SINTEF dyad is the main producer of marine technology publications, producing almost two thirds (65%) of the authorship shares.

Marine engineering publications are mostly in marine, ocean and civil engineering or in oceanography. The MNCS of Norway's marine engineering publications has hovered around a mean of 104 in the period 2013-2021.

Figure 11 shows the MNCS of the sub-fields for 2019-2022, with most fields performing above the world average, but mechanical engineering lagging substantially behind. Norwegian marine engineering research is thus both specialised in, and good at, relevant applied engineering sub-fields.

Sector	NTNU	Number of publications	Modified author shares	Share mod. author shares
`Higher education sector	NTNU	184	142.4	48.9%
	UiS	46	35.8	12.3%
	UiT	16	11.2	3.8%
	UNIS	21	10.2	3.5%
	UiO	12	7.3	2.5%
	OsloMet	10	6.0	2.1%
	USN	7	5.2	1.8%
	Other units	14	8.6	3.0%
Research Institutes	SINTEF Ocean	59	38.7	13.3%
	SINTEF	9	6.9	2.4%
	NORCE	6	4.3	1.5%
	NGI	6	3.5	1.2%
	FFI	7	3.3	1.1%
	Other units	15	7.8	2.7%

Table 20 Norwegian organisations with the largest Marine Technology publication output in 2022

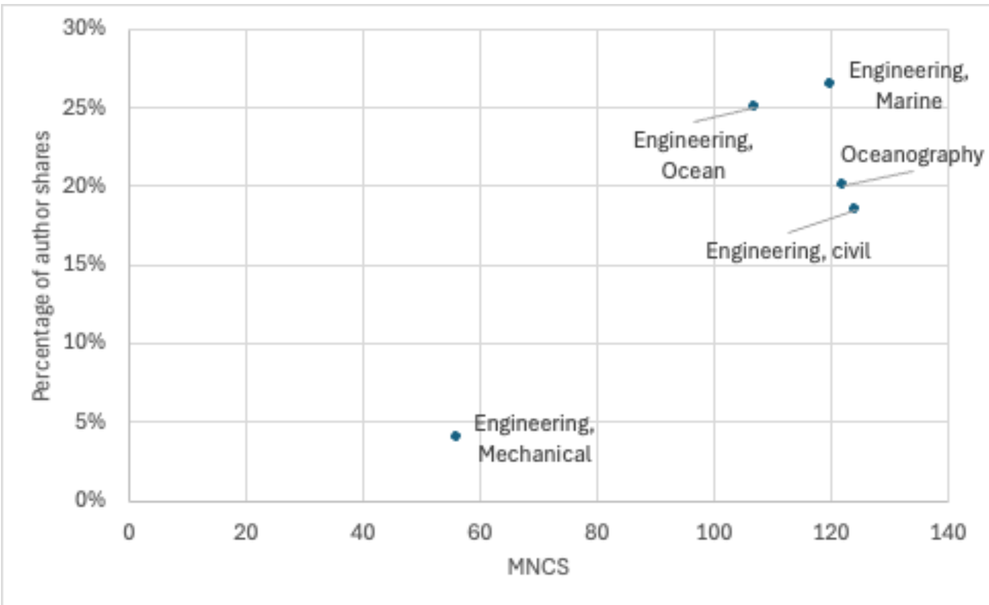

Figure 11 Proportion of article production and MNCS, Norwegian Marine Technology publications, 2019-2022

Technology: Other technologies

NTNU is the dominant producer of publications in 'other technologies'. Many (62%) are produced within the NTNU-SINTEF sphere, but there are also a good many other national partners. Civil engineering accounts for the biggest share of publication output, but a broad range of other fields is also involved (Table 21). The mean MNCS across the 2013-2021 period is 118, but there are also fairly big annual fluctuations. Most of the sub-fields are at or above the world average level of citations Figure 12).

Sector	Institution/institute	Number of publications	Modified author shares	Share mod. author shares
Higher education sector	NTNU	605	415.4	51.9%
	UiS	74	50.5	6.3%
	UiA	47	34.9	4.4%
	UiO	40	23.1	2.9%
	OsloMet	36	21.9	2.7%
	UiT	29	18.9	2.4%
	NMB	25	15.1	1.9%
	USN	23	14.5	1.8%
	HVL	20	13.4	1.7%
	Other units	42	26.4	3.3%
Research Institutes	SINTEF	54	33.1	4.1%
	SINTEF Energy	49	32.1	4.0%
	NGI	42	27.9	3.5%
	SINTEF Ocean	31	19.0	2.4%
	TØI	16	13.0	1.6%
	NORCE	11	7.0	0.9%
	Other units	58	32.0	4.0%

Table 21 Norwegian organisations with the largest publication output in 'Other Technologies' 2022

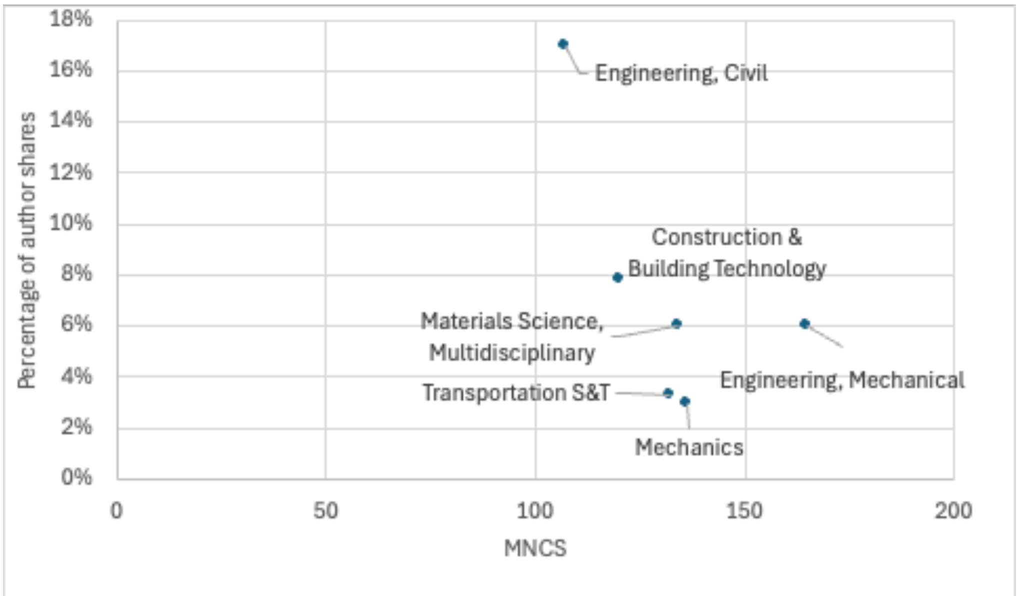

Figure 12 Proportion of article production and MNCS, Norwegian Other Technology & Engineering publications, 2019-2022, selected large fields

Appendix 3. Description of the evaluation process

Evaluation process and methods

The evaluation of mathematics, ICT and technology was conducted between the autumn of 2023 to the spring of 2025. It was carried out by international peers, using an Evaluation protocol developed by RCN (Appendix 3), *Evaluation of mathematics, ICT and technology in Norway 2023-2025.* The evaluation protocol is the same as used in the evaluation of Natural sciences and was approved by the portfolio board of Natural sciences and technology April 2022.

Institutions that were relevant for the evaluation of mathematics, ICT and technology were invited to participate. The evaluation included 56 administrative units (such as faculty, department, institution) which were submitted for evaluation by the host institution. The administrative units submitted their research groups, 248 in total. The institutions have been allowed to submit and adapt the evaluation mandate (Terms of Reference) to their own strategic goals. This is to ensure that the results of the evaluation will be useful for the institution's strategic development. The administrative unit together with the research group(s) selected appropriate benchmarks for each of the research group(s).

The evaluation reports will give important input to the individual administrative units, and provide important inputs to the Research Council, to relevant ministries and to any other bodies involved in the development of Norwegian research. Each institution/administrative unit is responsible for following up the recommendations that apply to their own institution. The Research Council will use the evaluation reports in the development of funding instruments and as basis for advice to the Government.

Organisation of the evaluation

The research evaluation has been evaluated at three levels:

- *National committee*

The National Evaluation Committee consisted of the four chairs of the evaluation committees plus additional two members to cover chemistry, physics and geosciences. The National Evaluation Committee was requested to produce a report based on the assessments and recommendations from the 56 independent administrative unit reports, and the national-level assessments produced by the expert panels and additional documents provided by RCN.

- *Evaluation committees*

The administrative units were assessed by evaluation committees according to sectorial affiliation and/or other relevant similarities between the units. The evaluation committee has expertise in the main disciplines of the natural sciences and various aspects of the organisation and management of research and higher education. The committees consisted of 6-8 international evaluation members per evaluation committee.

- *Expert panels*

The administrative units enrolled their research groups to be assessed by expert panels organised by research subjects or themes. The expert panels assessed 248 research groups across institutions and sectors and provided one evaluation report for each research group. The expert panels consisted of 4-7 international experts per panel.

The Research Council has established an external academic secretariat for the evaluation. The external evaluation secretariat is responsible for the implementation of the evaluation.

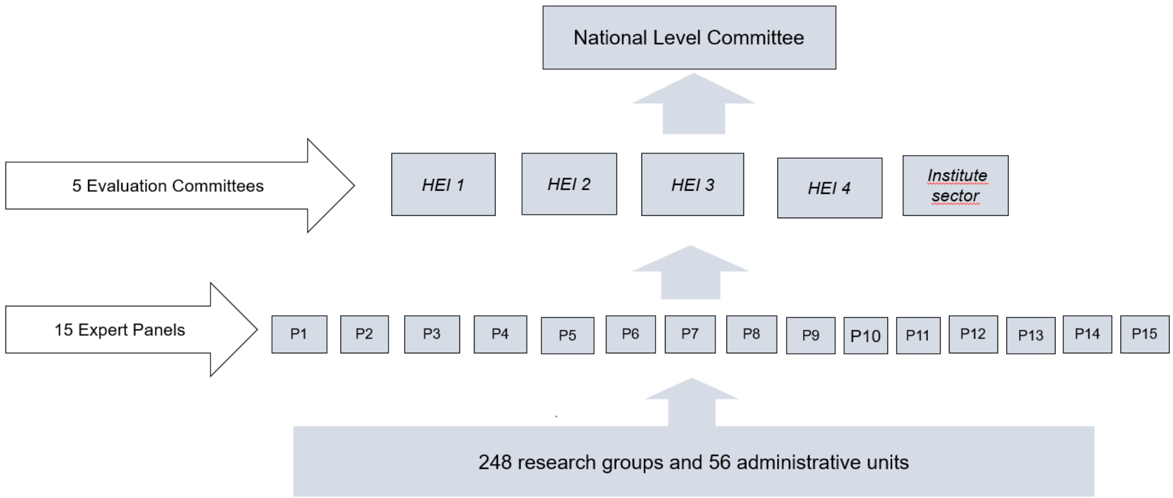

Figure 1. Organisation of the evaluation of mathematics, ICT and technology in three levels; expert panels, evaluation committees and national committee.

Data available

The documentary inputs to the evaluation were:

- Evaluation Protocol Evaluation of mathematics, ICT and technology in Norway 2022-2023
- Administrative Unit´s Terms of Reference
- Administrative Unit's self-assessment report
- Administrative Unit's impact cases
- Administrative Unit's research groups evaluation reports
- Panel reports from the Expert panels
- Bibliometric data (NIFU Nordic Institute for Studies of innovation, research and education)
- Personnel data (Statistics Norway (SSB))
- Funding data – The Research Council´s contribution to natural sciences research (RCN)
- Extract from the Survey for academic staff and the Student Survey (Norwegian Agency for Quality Assurance in Education (NOKUT))

Evaluation Criteria

The administrative units were evaluated on all five evaluation criteria cf. the evaluation protocol:

2.1 Strategy, resources and organisation
2.2 Research production, quality, and integrity
2.3 Diversity and equality
2.4 Relevance to institutional and sectoral purposes
2.5 Relevance to society

Panel no.	Description
1	Algebra and algebraic geometry; Geometry and topology; Operator algebra; Cryptography; Mathematic analysis; Logics; Mathematical physics; Mathematics/ICT didactics
2	Applied mathematics; Computational and numerical mathematics; Applied mathematical analysis; PDEs; Optimisation theory; Mathematical modelling; Industrial mathematics; Fluid mechanics; Biomathematics; Scientific computing: HPC
3	Statistics and data analysis; Stochastic analysis and risk analysis; Insurance mathematics; Machine learning/Artificial intelligence; Data Science; Data Mining/Big data; Language technology
4	Cybersecurity; Cryptography; Communication systems; Multimedia and speech processing; Networks; Distributed systems; Internet of things (IoT)
5	Virtual reality: Visualization; Visual computing; Image processing/analysis; Human computer interaction; Earth observation
6	Control theory and robotics; Autonomous systems;
7	Digitalization; Software engineering; Information systems; Programming technology; Reliable systems; Digital systems and organization; Formal Methods; eLearning
8	Micro and nanotechnology; Materials technology (incl. solar); Sensor technology, Medical ICT; Signal processing
9	Industrial technologies; Circuit design; Acoustics; Electro-technical subjects; Industry, product, and component design; Cyber-physical Systems;
10	Renewable energy production (hydropower, wind power, solar energy and bioenergy); Energy system; Energy efficiency; Energy transition, Thermal energy storage; Batteries and hydrogen production
11	Engineering technology; Technical geosciences and engineering geology; Applied mechanics; Heat and energy transport; Energy storage; Energy and process technology;
12	Structural engineering; Building and construction engineering; Building materials; Construction processes and digitalization; Building physics; Concrete; Water and wastewater systems engineering; Energy efficiency in buildings and areas; Climate adaptation of buildings and infrastructure
13	Marine and ocean technology; Ship design; Hydrodynamics; Marin structural design and production technology; Ship machinery and propulsion; System engineering
14	Petroleum technology; Drilling and well technology; Reservoir technology; Basin geology; Multiphase separation and -transport (oil/gas); Processing; CO2 capture, transport and storage (CCS); Geothermal energy
15	Applied AI and data science; Industrial applications; Information technology; Innovation; Entrepreneurship; Digital transformation

Table 22 Panel descriptions; Evaluation of mathematics, ICT and technology EVALMIT (2023-2024)

The research groups were evaluated on the evaluation criteria 2.1 Strategy, resources, and organisation and 2.2 Research production, quality and integrity. The research groups got five scores based on the three dimensions: Organisational dimension, two scores for Quality dimension and two scores for Societal impact dimension.

Table 23 shows the criteria used for judging publication quality and societal impact dimensions, referred to in Figure 1 and Figure 2.

Score	Research and publication quality	Research group’s societal contribution, taking into consideration the resources available to the group
5	Quality that is outstanding in terms of originality, significance, and rigour.	The group has contributed extensively to economic, societal and/or cultural development in Norway and/or internationally.
4	Quality that is internationally excellent in terms of originality, significance and rigour but which falls short of the highest standards of excellence.	The group's contribution to economic, societal and/or cultural development in Norway and/or internationally is very considerable given what is expected from groups in the same research field.
3	Quality that is recognised internationally in terms of originality, significance and rigour.	The group's contribution to economic, societal and/or cultural development in Norway and/or internationally is on par with what is expected from groups in the same research field.
2	Quality that meets the published definition of research for the purposes of this assessment.	The group's contribution to economic, societal and/or cultural development in Norway and/or internationally is modest given what is expected from groups in the same research field.
1	Quality that falls below the published definition of research for the purposes of this assessment.	There is little documentation of contributions from the group to economic, societal and/or cultural development in Norway and/or internationally.

Table 23 Criteria for scoring publication quality and societal impact at research group level

Limitations

This national report of the evaluation of Mathematics, ICT and Technology research in Norway 2023-2025 is based on an extensive process of peer review at three levels: research groups; administrative units (faculty/institute/centre/institution); and the national level.

In most cases, the research groups and administrative units involved invested a great deal of time and thought in preparing their self-assessments. In some cases it would have been useful if the research groups had given more attention to their societal impact, because this aspect is important not only at the policymaking and political levels but also to the wider public. In many impact case studies there was a welcome focus on the research done but too little account was taken of the need to evidence societal impact. This limited the ability of the evaluation to demonstrate the societal importance of the research.

In the ideal case, evaluations like this one would be done through site visits. Unfortunately, that would not only be unreasonably expensive but also make it impossible to find experts able to devote the large amounts of time it would require. The process used here appears to be a useful compromise that has worked well.

Opportunities for improvement include:

- More precise instructions for writing and evidencing impact case studies. It should, however, be recognised that this would increase the self-evaluation workload on the groups and administrative units
- Considering how to create a more direct link from the research group evaluations, which are focused on research, to the national report. The architecture used in EVALMIT means there is a loss of information between the research group and national levels as information passes through the administrative unit level

Appendix 4. Evaluation protocol including Terms of Reference

This protocol contains in Appendix A an unfilled form with instructions, as seen by the organisations participating in EVALMIT.

The Research Council of Norway

Evaluation of mathematics, ICT and

technology in Norway 2022-2024

EVALMIT protocol version 1.0

By decision of the Portfolio board for Natural sciences and Technology April 5, 2022

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Introduction

Research assessments based on this protocol serve different aims and have different target groups. The primary aim of the evaluation of mathematics, ICT and technology is to reveal and confirm the quality and the relevance of research performed at Norwegian Higher Education Institutions (HEIs), and by the institute sector. These institutions will hereafter be collectively referred to as Research Performing Organisations (RPOs). The assessments should serve a formative purpose by contributing to the development of research quality and relevance at these institutions and at the national level.

Evaluation units

The assessment will comprise a number of *administrative units* submitted for evaluation by the host institution. By assessing these administrative units in light of the goals and strategies set for them by their host institution, it will be possible to learn more about how public funding is used at the institution(s) to facilitate high-quality research and how this research contributes to society. The administrative units will be assessed by evaluation committees according to sectoral affiliation and/or other relevant similarities between the units.

The administrative units will be invited to submit data on their *research groups* to be assessed by expert panels organised by research subject or theme. See Chapter 3 for details on organisation.

Administrative unit	An administrative unit is any part of an RPO that is recognised as a formal (administrative) unit of that RPO, with a designated budget, strategic goals and dedicated management. It may, for instance, be a university faculty or department, a department of an independent research institute or a hospital.
Research group	Designates groups of researchers within the administrative units that fulfil the minimum requirements set out in section 1.2. Research groups are identified and submitted for evaluation by the administrative unit, which may decide to consider itself a single research group.

Minimum requirements for research groups

1) The research group must be sufficiently large in size, i.e. at least five persons in full-time positions with research obligations. This merely indicates the minimum number, and larger units are preferable. In exceptional cases, the minimum number may include PhD students, postdoctoral fellows and/or non-tenured researchers. *In all cases, a research group must include at least three full-time tenured staff*. Adjunct professors, technical staff and other relevant personnel may be listed as group members but may not be included in the minimum number.
2) The research group subject to assessment must have been established for at least three years. Groups of more recent date may be accepted if they have come into existence as a consequence of major organisational changes within their host institution.
3) The research group should be known as such both within and outside the institution (e.g. have a separate website). It should be able to document common activities and results in the form of co-publications, research databases and infrastructure, software, or shared

responsibilities for delivering education, health services or research-based solutions to designated markets.

4) In its self-assessment, the administrative unit should propose a suitable benchmark for the research group. The benchmark will be considered by the expert panels as a reference in their assessment of the performance of the group. The benchmark can be grounded in both academic and extra-academic standards and targets, depending on the purpose of the group and its host institution.

The evaluation in a nutshell

The assessment concerns:

- research that the administrative unit and its research groups have conducted in the previous 10 years
- the research strategy that the administrative units under evaluation intend to pursue going forward
- the capacity and quality of research in mathematics, ICT and technology at the national level

The Research Council of Norway (RCN) will:

- provide a template for the Terms of Reference[13] for the assessment of RPOs and a national-level assessment in mathematics, ICT and technology appoint members to evaluation committees and expert panels
- provide secretarial services
- commission reports on research personnel and publications based on data in national registries
- take responsibility for following up assessments and recommendations at the national level.

RPOs conducting research in mathematics, ICT and technology are expected to take part in the evaluation. The board of each RPO under evaluation is responsible for tailoring the assessment to its own strategies and specific needs and for following them up within their own institution. Each participating RPO will carry out the following steps:

1) Identify the administrative unit(s) to be included as the main unit(s) of assessment
2) Specify the Terms of Reference by including information on specific tasks and/or strategic goals of relevance to the administrative unit(s)
3) The administrative unit will, in turn, be invited to register a set of research groups that fulfil the minimum criteria specified above (see section 1.2). The administrative unit may decide to consider itself a single research group.
4) For each research group, the administrative unit should select an appropriate benchmark in consultation with the group in question. This benchmark can be a reference to an academic level of performance or to the group's contributions to other institutional or sectoral purposes (see section 2.4). The benchmark will be used as a reference in the assessment of the unit by the expert panel.
5) The administrative units subject to assessment must provide information about each of their research groups, and about the administrative unit as a whole, by preparing self-assessments and by providing additional documentation in support of the self-assessment.

13 The terms of reference (ToR) document defines all aspects of how the evaluation committees and expert panels will conduct the [research area] evaluation. It defines the objectives and the scope of the evaluation, outlines the responsibilities of the involved parties, and provides a description of the resources available to carry out the evaluation.

Target groups

- Administrative units represented by institutional management and boards
- Research groups represented by researchers and research group leaders
- Research funders
- Government

The evaluation will result in recommendations to the institutions, the RCN and the ministries. The results of the evaluation will also be disseminated for the benefit of potential students, users of research and society at large.

This protocol is intended for all participants in the evaluation. It provides the information required to organise and carry out the research assessments. Questions about the interpretation or implementation of the protocol should be addressed to the RCN.

Assessment criteria

The administrative units are to be assessed on the basis of five assessment criteria. The five criteria are applied in accordance with international standards. Finally, the evaluation committee passes judgement on the administrative units as a whole in qualitative terms. In this overall assessment, the committee should relate the assessment of the specific tasks to the strategic goals that the administrative unit has set for itself in the Terms of Reference.

When assessing administrative units, the committees will build on a separate assessment by expert panels of the research groups within the administrative units. See Chapter 3 'Evaluation process and organisation' for a description of the division of tasks.

Strategy, resources and organisation

The evaluation committee assesses the framework conditions for research in terms of funding, personnel, recruitment and research infrastructure in relation to the strategic aims set for the administrative unit. The administrative unit should address at least the following five specific aspects in its self-assessment: 1) funding sources, 2) national and international cooperation, 3) cross-sector and interdisciplinary cooperation, 4) research careers and mobility, and 5) Open Science. These five aspects relate to how the unit organises and actually performs its research, its composition in terms of leadership and personnel, and how the unit is run on a day-to-day basis.

To contribute to understanding what the administrative unit can or should change to improve its ability to perform, the evaluation committee is invited to focus on factors that may affect performance.

Further, the evaluation committee assesses the extent to which the administrative unit's goals for the future remain scientifically and societally relevant. It is also assessed whether its aims and strategy, as well as the foresight of its leadership and its overall management, are optimal in relation to attaining these goals. Finally, it is assessed whether the plans and resources are adequate to implement this strategy.

Research production, quality and integrity

The evaluation committee assesses the profile and quality of the administrative unit's research and the contribution the research makes to the body of scholarly knowledge and the knowledge base for other relevant sectors of society. The committee also assesses the scale of the unit's research results (scholarly publications, research infrastructure developed by the unit, and other contributions to the field) and its contribution to Open Science (early knowledge and sharing of data and other relevant digital objects, as well as science communication and collaboration with societal partners, where appropriate).

The evaluation committee considers the administrative unit's policy for research integrity and how violations of such integrity are prevented. It is interested in how the unit deals with research data, data management, confidentiality (GDPR) and integrity, and the extent to which independent and critical pursuit of research is made possible within the unit. Research integrity relates to both the scientific integrity of conducted research and the professional integrity of researchers.

Diversity and equality

The evaluation committee considers the diversity of the administrative unit, including gender equality. The presence of differences can be a powerful incentive for creativity and talent development in a diverse administrative unit. Diversity is not an end in itself in that regard, but a tool for bringing together different perspectives and opinions.

The evaluation committee considers the strategy and practices of the administrative unit to prevent discrimination on the grounds of gender, age, disability, ethnicity, religion, sexual orientation or other personal characteristics.

Relevance to institutional and sectoral purposes

The evaluation committee compares the relevance of the administrative unit's activities and results to the specific aspects detailed in the Terms of Reference for each institution and to the relevant sectoral goals (see below).

Higher Education Institutions

There are 36 Higher Education Institutions in Norway that receive public funding from the Ministry for Education and Research. Twenty-one of the 36 institutions are owned by the ministry, whereas the last 15 are privately owned. The HEIs are regulated under the Act relating to universities and university colleges of 1 August 2005.

The purposes of Norwegian HEIs are defined as follows in the Act relating to universities and university colleges[14]

- provide higher education at a high international level;
- conduct research and academic and artistic development work at a high international level;
- disseminate knowledge of the institution's activities and promote an understanding of the principle of academic freedom and application of scientific and artistic methods and results in the teaching of students, in the institution's own general activity as well as in public administration, in cultural life and in business and industry.

In line with these purposes, the Ministry for Research and Education has defined four overall goals for HEIs that receive public funding. These goals have been applied since 2015:

[14] https://lovdata.no/dokument/NLE/lov/2005-04-01-15?q=universities

1) High quality in research and education
2) Research and education for welfare, value creation and innovation
3) Access to education (esp. capacity in health and teacher education)
4) Efficiency, diversity and solidity of the higher education sector and research system

The committee is invited to assess to what extent the research activities and results of each administrative unit have contributed to sectoral purposes as defined above. In particular, the committee is invited to take the share of resources spent on education at the administrative units into account and to assess the relevance and contributions of research to education, focusing on the master's and PhD levels. This assessment should be distinguished from an assessment of the quality of education in itself, and it is limited to the role of research in fostering high-quality education.

Research institutes (the institute sector)

Norway's large institute sector reflects a practical orientation of state R&D funding that has long historical roots. The Government's strategy for the institute sector[15] applies to the 33 independent research institutes that receive public basic funding through the RCN, in addition to 12 institutes outside the public basic funding system.

The institute sector plays an important and specific role in attaining the overall goal of the national research system, i.e. to increase competitiveness and innovation power to address major societal challenges. The research institutes' contributions to achieving these objectives should therefore form the basis for the evaluation. The main purpose of the sector is to conduct independent applied research for present and future use in the private and public sector. However, some institutes primarily focus on developing a research platform for public policy decisions, others on fulfilling their public responsibilities.

The institutes should:

- maintain a sound academic level, documented through scientific publications in recognised journals
- obtain competitive national and/or international research funding grants
- conduct contract research for private and/or public clients
- demonstrate robustness by having a reasonable number of researchers allocated to each research field

The committee is invited to assess the extent to which the research activities and results of each administrative unit contribute to sectoral purposes and overall goals as defined above. In particular, the committee is invited to assess the level of collaboration between the administrative unit(s) and partners in their own or other sectors.

The hospital sector (only relevant for evaluation of medicine and health research)

There are four regional health authorities (RHFs) in Norway. They are responsible for the specialist health service in their respective regions. The RHFs are regulated through the Health Enterprises Act of 15 June 2001 and are bound by requirements that apply to specialist and other health services, the Health Personnel Act and the Patient Rights Act. Under each of the regional health authorities, there are several health trusts (HFs), which can consist of one or more hospitals. A health trust (HF) is wholly owned by an RHF.

Research is one of the four main tasks of hospital trusts.[16] The three other mains tasks are to ensure good treatment, education and training of patients and relatives. Research is important if the health

[15] Strategy for a holistic institute policy (Kunnskapsdepartementet 2020)
[16] Cf. the Specialist Health Services Act § 3-8 and the Health Enterprises Act §§ 1 and 2

service is to keep abreast of stay up-to-date with medical developments and carry out critical assessments of established and new diagnostic methods, treatment options and technology, and work on quality development and patient safety while caring for and guiding patients.

The committee is invited to assess the extent to which the research activities and results of each administrative unit have contributed to sectoral purposes as described above. The assessment does not include an evaluation of the health services performed by the services.

Relevance to society

The committee assesses the quality, scale and relevance of contributions targeting specific economic, social or cultural target groups, of advisory reports on policy, of contributions to public debates, and so on. The documentation provided as the basis for the assessment of societal relevance should make it possible to assess relevance to various sectors of society (i.e. business, the public sector, non-governmental organisations and civil society).

When relevant, the administrative units will be asked to link their contributions to national and international goals set for research, including the Norwegian Long-term Plan for Research and Higher Education and the UN Sustainable Development Goals. Sector-specific objectives, e.g. those described in the Development Agreements for the HEIs and other national guidelines for the different sectors, will be assessed as part of criterion 2.4.

The committee is also invited to assess the societal impact of research based on case studies submitted by the administrative units and/or other relevant data presented to the committee. Academic impact will be assessed as part of criterion 2.2.

Evaluation process and organisation

The RCN will organise the assessment process as follows:

- Commission a professional secretariat to support the assessment process in the committees and panels, as well as the production of self-assessments within each RPO
- Commission reports on research personnel and publications within mathematics, ICT and technology based on data in national registries
- Appoint one or more evaluation committees for the assessment of administrative units.
- Divide the administrative units between the appointed evaluation committees according to sectoral affiliation and/or other relevant similarities between the units.
- Appoint a number of expert panels for the assessment of research groups submitted by the administrative units.
- Divide research groups between expert panels according to similarity of research subjects or themes.
- Task the chairs of the evaluation committees with producing a national-level report building on the assessments of administrative units and a national-level assessments produced by the expert panels.

Committee members and members of the expert panels will be international, have sufficient competence and be able, as a body, to pass judgement based on all relevant assessment criteria. The RCN will facilitate the connection between the assessment levels of panels and committees by appointing committee members as panel chairs.

Division of tasks between the committee and panel levels

The expert panels will assess research groups across institutions and sectors, focusing on the first two criteria specified in Chapter 2: 'Strategy, resources and organisation' and 'Research production and quality' The assessments from the expert panels will also be used as part of the evidence base for a report on Norwegian research within mathematics, ICT and technology (see section 3.3).

The evaluation committees will assess the administrative units based on all the criteria specified in Chapter 2. The assessment of research groups delivered by the expert panels will be a part of the evidence base for the committees' assessments of administrative units. See figure 1 below.

The evaluation committee has sole responsibility for the assessments and any recommendations in the report. The evaluation committee reaches a judgement on the research based on the administrative units and research groups' self-assessments provided by the RPOs, any additional documents provided by the RCN, and interviews with representatives of the administrative units. The additional documents will include a standardised analysis of research personnel and publications provided by the RCN.

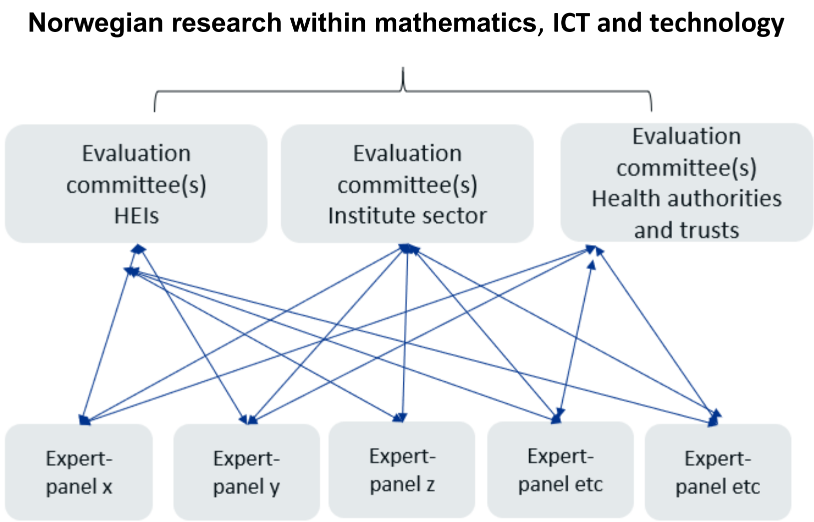

Figure 1. Evaluation committees and expert panels (Health authorities and trusts are only relevant for evaluation of medicine and health)

The evaluation committee takes international trends and developments in science and society into account when forming its judgement. When judging the quality and relevance of the research, the committees shall bear in mind the specific tasks and/or strategic goals that the administrative unit has set for itself including sectoral purposes (see section 2.4 above).

Accuracy of factual information

The administrative unit under evaluation should be consulted to check the factual information before the final report is delivered to the RCN and the board of the institution hosting the administrative unit.

National level report

Finally, the RCN will ask the chairs of the evaluation committees to produce a national-level report that builds on the assessments of administrative units and the national-level assessments produced by the expert panels. The committee chairs will present their assessment of Norwegian research in mathematics, ICT and technology at the national level in a separate report that pays specific attention to:

- Strengths and weaknesses of the research area in the international context
- The general resource situation regarding funding, personnel and infrastructure
- PhD training, recruitment, mobility and diversity
- Research cooperation nationally and internationally
- Societal impact and the role of research in society, including Open Science

This national-level assessment should be presented to the RCN.

Appendix A: Terms of References (ToR)

[Text in red to be filled in by the Research-performing organisations (RPOs)]

The board of [RPO] mandates the evaluation committee appointed by the Research Council of Norway (RCN) to assess [administrative unit] based on the following Terms of Reference.

Assessment
You are asked to assess the organisation, quality and diversity of research conducted by [administrative unit] 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 [n] aspects in your assessment:

1. …
2. …
3. …
4. …

…

[To be completed by the board: specific aspects that the evaluation committee should focus on – they may be related to a) strategic issues, or b) an administrative unit's specific tasks.]

In addition, we would like your report to provide a qualitative assessment of [administrative unit] 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
- [to be completed by the board]

Interviews with representatives from the evaluated units
Interviews with the [administrative unit] will be organised by the evaluation secretariat. Such interviews can be organised as a site visit, in another specified location in Norway or as a video conference.

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

Assessment report
We ask you to report your findings in an assessment report drawn up in accordance with a format specified by the mathematics, ICT and technology secretariat. The committee may suggest adjustments to this format at its first meeting. A draft report should be sent to the [administrative unit] and RCN]. The [administrative unit] should be allowed to check the report for factual inaccuracies; if such inaccuracies are found, they should be reported to the mathematics, ICT and technology secretariat within the deadline given by the secretariat. After the committee has made the amendments judged necessary, a corrected version of the assessment report should be sent to the board of [the RPO] and the RCN after all feedback on inaccuracies has been received from [administrative unit].

Appendix B: Data sources

The lists below show the most relevant data providers and types of data to be included in the evaluation. Data are categorised in two broad categories according to the data source: National registers and self-assessments prepared by the RFOs. The RCN will commission an analysis of data in national registers (R&D-expenditure, personnel, publications etc.) to be used as support for the committees' assessment of administrative units. The analysis will include a set of indicators related to research personnel and publications.

Data providers

- Norwegian Agency for Quality Assurance in Education (NOKUT)
- Research Council of Norway (RCN)
- Statistics Norway (SSB)
- Nordic institute for studies of innovation, research and education (NIFU)

Available data material

1) **Administrative unit**
    a. **Data from administrative units:**
        i. *Self-assessment covering all assessment criteria*
        ii. *Administrative data on funding sources*
        iii. *Administrative data on personnel*
        iv. *Administrative data on research infrastructure and other support structures*
        v. *SWOT analysis*
        vi. *Impact cases*
        vii. *Any supplementary data needed to assess performance related to the Terms of Reference, strategic goals and specific tasks of the unit*
    b. **Data from expert panels**
        i. *Panel report for each expert panel in the evaluation*
        ii. *Assessment reports per participating research group*
    c. **Data from National data providers**
        i. *Publication and citation analysis (NIFU)*
        ii. *Statistics for use in the evaluations (SSB)*
        iii. *The Norwegian Research System (NIFU)*
        iv. *Bibliometrics Higher Education Sector (NIFU)*
        v. *Bibliometrics Institute Sector (NIFU)*
    d. **Data from the Research Council of Norway**
        i. *Research Council of Norway contribution to the evaluation (RCN)*
        ii. *Extract from the Survey of academic staff (NOKUT)*
        iii. *Extract of the Student Survey (NOKUT)*

2) **Research groups**

    b. Data from the research groups
        i. *Self-assessment covering the first two assessment criteria (see Table 1)*
        ii. *Research group data on funding sources*
        iii. *Research group data on personnel*
        iv. *Publication profiles*
        v. *Example publications and other research results (databases, software etc.) The examples should be accompanied by an explanation of the groups' specific contributions to the result*

   vi. *Any supplementary data needed to assess performance related to the benchmark defined by the administrative unit*

c. Data from National data providers

   i. *Publication and citation analysis (NIFU)*

The table below shows how different types of evaluation data may be relevant to different evaluation criteria. Please note that the self-assessment produced by the administrative units in the form of a written account of management, activities, results etc. should cover all criteria. A template for the self-assessment of research groups and administrative units will be commissioned by the RCN from the mathematics, ICT and technology secretariat for the evaluation.

Table 1. Types of evaluation data per criterion (changes may occur)

Evaluation units / **Criteria**	**Research groups**	**Administrative units**
Strategy, resources and organisation	Self-assessment Data from National data providers	Self-assessment Terms of Reference Research groups assessment reports Data from National data providers and RCN
Research production and quality	Self-assessment Example publications (and other research results)	Self-assessment Research groups assessment reports Data from National data providers and RCN
Diversity, equality and integrity		Self-assessment Research groups assessment reports Data from National data providers and RCN
Relevance to institutional and sectoral purposes		Self-assessment Impact cases Data from National data providers and RCN
Relevance to society		Self-assessment Impact cases Data from National data providers and RCN
Overall assessment	*Data related to:* *Benchmark defined by administrative unit*	*Data related to:* *Strategic goals and specific tasks of the admin. unit*

Appendix 5. List of participating administrative units

Institution	Administrative Unit	Research Group
University of Oslo	Department of Informatics	Analytical Solutions and Reasoning (ASR)
		Design of information systems (DESIGN)
		Digital Innovation (DIN)
		Digital Signal Processing and Image Analysis (DSB)
		Entrepreneurship group (ENT)
		Information Systems (IS)
		Language Technology Group (LTG)
		Nanoelectronics research group (NANO)
		Networks and Distributed Systems (ND)
		Reliable Systems (PSY)
		Programming Technology (PT)
		Robotics and Intelligent Systems (ROBIN)
		Scientific Computing and Machine Learning (SCML)
		Software Engineering (SE)
		Digital Security (SEC)
University of Oslo	Department of Mathematics	Mechanics - MEK
		Statistics and Data Science - Section 2
		Risk and Stochastics - RaS
		Partial differential equations and computational mathematics – section 4
		Algebra, Geometry and Topology - Section 5
		Several Complex Variables, Logic and Operator algebras – section 6
University of Bergen	Department of Informatics	Algorithms (Algo)
		Machine Learning (ML)
		Optimization (OPT)
		Programming Theory (PUT)
		Selmer Centre in Secure Communication (SC)
		Visualization Research Group (VisGroup)
University of Bergen	Department of Mathematics	Algebra, algebraic geometry and topology (AGATA)
		Analysis and PDE (AnPDE)
		Fluid Mechanics (FM)
		Porous Media Research Group (PMG)
		Statistics and data science
University of Bergen	Department of Physics and Technology (IFT)	Reservoir Physics – Energy Technology and CO2 storage (CCUS)
		Energy and Process Technology (EPT)
University of Bergen	Department of Information Science and Media Studies (InfoMedia)	The HCI research group (HCI)
		Intelligent Information Systems (I2S)

Institution	Administrative Unit	Research Group
		Logic and Artificial Intelligence (LAI)
		Behavioural Data Analytics & Recommender Systems Research Group (DARS)
UiT the Arctic University of Norway	Department of Automation and Process Engineering (IAP)	IR, Spectroscopy and Numerical Modelling Research Group (IRSNM)
UiT the Arctic University of Norway	Department of Building, Energy and Material Technology	Building, Energy and Materials (BEaM)
UiT The Arctic University of Norway	Department of Computer Science (IFI)	Arctic Green Computing Group (AGC)
		Computational Analytics and Intelligence (CAI)
		Cyber-Physical and IoT Systems (CPS)
		Cyber Security Group (CSG)
		Health Data Lab (HDL)
		Health Informatics and -Technology (HIT)
		Open Distributed Systems (ODS)
UiT The Arctic University of Norway	Department of Computer Technology and Computational Engineering (IDBI)	Simulations
UiT The Arctic University of Norway	Department of electrical engineering (IET)	Electromechanical systems (ElMech)
UiT The Arctic University of Norway	Department of Industrial Technology	Arctic Technology & Icing Research Group (arcICE)
		Intelligent Manufacturing and Logistics (IMaLog)
UiT The Arctic University of Norway	Department for Mathematics and Statistics (IMS)	Applied and Computational Algebra, ACAG
		Complex Systems Modelling (CoSMo)
		Geometry and Mathematical Physics
UiT The Arctic University of Norway	Department of Physics and Technology (IFT)[1]	Machine Learning Group (MLG)
UiT The Arctic University of Norway	Department of technology and Safety (ITS)	Sustainable Technology and Safety (STS
		Advanced maritime ship operations (AMSO)
University of Stavanger (UiS	Department of Electrical Engineering and Computer Science (IDE)	Cybernetics and Biomedical Engineering (CBE)
		Computer Science
		Data Science and Artificial Intelligence
University of Stavanger (UiS	Department of Energy and Petroleum Engineering – IEP	Drilling and Well Technology – DWT
		Energy Technology - ET
University of Stavanger (UiS	Department of Mechanical and Structural Engineering and Material Science (IMBM)	Structural engineering Research group (BYGG)
		Marine and Offshore Technology, Marin (M&O)
		Mechanical Engineering and Industrial Asset Management, Maskin og IAM (MEIAM)
University of Stavanger (UiS	Department of Mathematics and Physics, IMF	Geometry and Analysis, GeoAna
		Statistics
		Theoretical Subatomic Physics and Cosmology (TSPC)
		Materials Physics (MP)

Institution	**Administrative Unit**	**Research Group**
Norwegian University of Science and Technology - NTNU	Department of Architecture and Technology – IAT	Energy and Environment Group
Norwegian University of Science and Technology - NTNU	Department of Civil and Environmental Engineering (DCEE)	Building Technology - BT
		Building Process (BP)
		Geomatics
		Geotechnical Engineering, Geotech
		Marine Civil Engineering (MB)
		Water and Wastewater (VA)
		Road, Railway and Transport Engineering (VJT)
		Hydraulic Engineering group (VT)
Norwegian University of Science and Technology - NTNU	Department of Computer Science (IDI)	Artificial Intelligence Foundations (AIFO)
		Algorithms, HPC and Systems
		Applied Artificial Intelligence
		Computer Architecture Lab (CAL)
		Computing Education Research Group
		Colourlab (Colourlab)
		Information Systems (IS)
		Intelligent Systems and Analytics (ISA)
		Software Engineering and Learning Technology (SE-LT)
		Visual Computing Group
Norwegian University of Science and Technology - NTNU	Department of Electric Energy (IEL)	Electrical Machines and Electromagnetics (EME)
		Electricity Markets and Energy System Planning (EMESP)
		High Voltage Technology (HVT)
		Power Electronics Systems and Components (PESC)
		Power System Operation and Analysis-PSOA
Norwegian University of Science and Technology - NTNU	Department of Electronic Systems (IES)	Acoustics group (AK)
		Electronic Systems Education (ESE)
		Circuit and Radio Systems group (KR)
		Nanoelectronics and Photonics (NF)
		Signal Processing Group (SI)
		Smart Wireless Systems (SWS)
Norwegian University of Science and Technology - NTNU	Department of Energy and Process Engineering (EPT)	Industrial Ecology Programme (IndEcol)
		Process and Power (PP)
		Sustainable Energy Systems (SES)
		Thermo-fluid (TF)
Norwegian University of Science and Technology - NTNU	Department of Engineering Cybernetics – DeptCybernetic	Cybernetics in Life Sciences-Biocybernetics
		Control and AI for Cyber-Physical Systems
		Robotics and Autonomous Systems – RAS

Institution	Administrative Unit	Research Group
Norwegian University of Science and Technology - NTNU	Department of Geoscience and Petroleum (IGP)	Engineering Geology and Rock Mechanics (EG&RM)
		Mineral Production and HSE
		Well and Reservoir (originally registered as Subsurface Technology)
		Research Group Geology
		Research Group Geophysics
Norwegian University of Science and Technology - NTNU	Department of ICT and Natural Sciences	Cyber-Physical Systems Lab
		Sustainable Digital Transformation Research and Development Group (SDT)
Norwegian University of Science and Technology - NTNU	Department of Information Security and Communication Technology, NTNU – IIK	Communication Technology, NTNU-IIK-COM (COM)
		the Discipline of Human, Organizational, and Societal Aspects (NTNU-IIK-HOS, HOS)
		Information Security Discipline (NTNU-IIK-INF)
		Discipline of Cryptology (NTNU-IIK-KRY, KRY)
Norwegian University of Science and Technology - NTNU	Department of Manufacturing and Civil Engineering (IVB)	Manufacturing Materials and Energy
		Civil engineering and geomatics group
Norwegian University of Science and Technology - NTNU	Department of Marine Technology (IMT)	Marine Energy Systems and Automatics (MESA)
		Marine Structures (MS)
		Marine Systems Design (MSD)
Norwegian University of Science and Technology - NTNU	Department of mathematical sciences (IMF)	Algebra
		Analysis
		Differential Equations and Numerical analysis (DNA)
		Geometry and Topology
		Statistics
Norwegian University of Science and Technology - NTNU	Department of Mechanical and Industrial Engineering (MTP)	Design, Analysis, Materials & Manufacturing (DAM)
		Production Management (PM)
		Project and Quality Management, PQL
		Robotics and Automation, RA
		Reliability, Availability, Maintainability and Safety, RAMS
Norwegian University of Science and Technology - NTNU	Structural Engineering (KT)	Concrete Group
		Nano and Biomechanics
		Structural Impact Laboratory (SIMLab)
		Structural Mechanics Group (KMEK)
University of Agder, UiA	Department of Information Systems (IIS)	Centre for Digital Transformation (CeDiT)
		Centre for Integrated Emergency Management (CIEM)
University of Agder, UiA	Faculty of Engineering and Science (TekReal)	Centre for Artificial Intelligent Research (CAIR)
		Civil and Structural research group (CSG)
		Electronics, IoT, and Mobile Communications
		Functional Analysis (FA)

Institution	Administrative Unit	Research Group
		Mathematics Education Research Group Agder (MERGA)
		Renewable Energy (REN)
		Cyber security, systems engineering, modelling (SYSEC)
		Mechatronics Section/Top Research Centre Mechatronics (TRCM)
Oslo Metropolitan University - OsloMet	Department of Built Environment (BE)	Structural Engineering Research Group (SERG)
		Sustainable Built Environment (SustainaBuilt)
Oslo Metropolitan University - OsloMet	Department of Computer Science	Applied AI research group (AI2)
		Autonomous Systems and Networks (ASN)
		Mathematical modelling research group (MatMod)
		Universal Design of Information and Communication Technologies (UD-ICT)
Oslo Metropolitan University - OsloMet	Department of Mechanical, Electronic and Chemical Engineering	ADEPT (Advanced Health Intelligence and Brain-inspired Technologies)
		Automation, Robotics, and Intelligent Systems (ARIS)
		Mechanics, Mechatronics and Material Technology (M3T
Norwegian University of Life Sciences (NMBU)	Faculty of Science and Technology (REALTEK)	Biospectroscopy and Data Modeling (BioSpec
		Material Theory and Informatics (MatInf)
		Robotics Group
University of South-Eastern Norway (USN)	Department of Electrical Engineering (IT) and Cybernetics (EIK)	Applied Modeling and Control (AMOC RG)
		Electrical Power Systems (EPS RG)
University of South-Eastern Norway (USN)	Department of Microsystems (IMS)	Biological Micro Electronic Mechanical Systems (BioMems)
		Materials and Micro-integration (matMicro)
University of South-Eastern Norway (USN)	Department of Process, Energy and Environmental Technology (PEM)	USN Research Group of Energy and Environmental Technology (URGENT)
University of South-Eastern Norway (USN)	Department of Science and Industry Systems (IRI)	Advanced Cognitive systems and Data Science (ACSAD)
		Norwegian Industrial Systems Engineering (NISE)
		Quantum Technology (QTECH)
University of South-Eastern Norway (USN)	USN School of Business	Management Information Systems (MIS)
Kristiania University College	School of Economics, Innovation and Technology/SEIT	The Behavior & Technology Lab/BTLab
		The Innovation and Digitalization for Enterprises And Society research laboratory (IDEAS Lab)
Western Norway University of Applied Sciences (HVL)	Faculty of Engineering and Natural Sciences (FIN) / Faculty of Technology, Environmental and Social Sciences (FTMS), from 1.1.2024	Nanofluids for energy and process technology (Nanofluids
		Software Engineering (SE)
		Wind, Water and Waves (W3)
		Glaciers Research Group (BRE)
		Landslides Research Group (SKRED)
Østfold University College (ØUC)	Faculty of Computer Science, Engineering and Economics (IIØ)	Green Energy Hub (GEH)
		Department of Computer Science and Communication (ITK)

Institution	Administrative Unit	Research Group
Institution	Administrative Unit	Research Group
NORCE Norwegian Research Centre (NORCE)	NORCE Energy and Technology	Subsurface Flow Laboratory (SFL)
	NORCE Teknologi	Air and Space
		Computational Geosciences and Modeling (CGM)
		Coastal and Ocean Systems (COS)
		Data, AI, Robotics, Vision, Visualization, Immersion (DARWIN)
		Data Assimilation and Optimization (DAO)
		Digital Systems (DS)
		Energy Modelling and Automation
		Autonomous Systems and IoT (IoT)
		Measurement Science
		Modelling and Simulation (ModSim)
		Well Operations and Risk Management (WORM)
SINTEF Community	SINTEF Community	Climate adaptation of the built environment (CLIMADAPT)
		Energy efficiency and flexibility in buildings and neighbourhoods (ENERFLEX)
SINTEF Digital	SINTEF Digital	Communication Systems (CS)
		Human Computer Interaction (HCI)
		Robotics and Control (RobCon)
		Acoustics / ACOU
		Computational Geosciences (COMG)
		Computational Science and Engineering (CSE)
		Computer Vision (CV)
		Cyber Security / CyberSec
		Digital Process Innovation (DPI)
		Geometry / GEO
		Trustworthy Green IoT Software / GIoT
		Optimization (OPT)
		Reliable automation (RA)
		Smart Data / SD
		Software Product Innovation / SPIN
		Analytics and AI / AAI
		Health Services Research / HSR*
		Applied Optics (AO)
		Medical Technology
		Micro-optics
		Silicon Sensor Technology
SINTEF Industry	SINTEF Industry	Applied Geoscience (AG)
		Formation Physics / FF
		Material- and Structural Mechanics (MSM)
		Batteries and Hydrogen Technologies (BHT)

Institution	Administrative Unit	Research Group
		Solar Energy and Materials
		Operations Research and Economics (IØO)
		New Energy Solutions (NES)
		Thin Film and Membrane Technology (TFMT)
		Casting, forming and recycling - SFR
		Polymer and composite materials — PKM
		Materials Integrity and Welding, MIW
		Corrosion and Tribology (CT)
		Drilling & well/DW
		Flow Technology (ST)
		Industrial Process design (IPD)
		Chemical and Environmental Process Engineering
		Multiphase Flow (FFS)
		Material Physics Oslo (MPO)
		Material Physics Trondheim (MPT)
		Electrolysis and High Temperature Materials (EHTM)
		Material Modelling and Processing
		Process Chemistry and Functional Materials (PCFM)
		Process Metallurgy and Raw Materials
SINTEF Energy	SINTEF Energy	Active Distribution Systems (ADS)
		Bioenergy (BIO)
		Energy Processes (EP)
		Insulation systems
		Offshore energy systems (OES)
		Thermodynamics (Thermo)
SINTEF Ocean	SINTEF Ocean	Aquaculture Robotics and Automation
		Experimental Hydrodynamics
		Marine CFD
		Marine Operations
		Marine Structures (MS)
		Maritime Energy Systems
		Maritime ICT and Cybernetics
		Ship Hydrodynamics
		Structural Mechanics (KT)
SINTEF Manufacturing	SINTEF Manufacturing	Digital Production / DP
		Industrial Robotics and Automation / RobAuto
Norwegian Computing Centre (NR)	Norwegian Computing Centre (NR)	Image analysis, Machine Learning and Earth observation s BAMJO
		Department of Applied Research in ICT (DART
		Statistical Analysis and Machine Learning for user motivated applications (SAMBA)
		Statistical Analysis of Natural Resource Data (SAND)

Institution	Administrative Unit	Research Group
Institute for Energy Technology (IFE)	Human and organisational factors (HOF)	Human and organisational factors (HOF)
	Energy and Energy Technology (ENET)	Solar Energy Materials and Technology
		Energy Materials, ENMAT/Battery Technology Department
		Department for Hydrogen Technology
		Department for Environmental Industrial Processes
		Department for Reservoir Technology
Simula Research Laboratory (SIMULA)	Simula Research Laboratory (SIMULA)	Communication Systems
		Cryptography (SUiB)
		Data Science
		Scientific Computing
		Software Engineering (SE)

1 research group from EVALMEDHELSE and 17 research groups from EVALNAT

Explanation color code:

	17 Research groups that are evaluated in EVALNAT, will be included in the Adm unit assessment in EVALMIT
	7 Research groups will not be included in any Adm Unit report in EVALMIT (only research group reports)
	1 Research group will be evaluated in EVALMEDHELSE but will be included in Adm unit report for EVALMIT.

Appendix 6. Members of the EVALMIT national committee

Krikor B Ozanyan (Chair)

Krikor B Ozanyan (FInstP, FIET, FHEArp, LifeSMIEEE) is Professor of Photonic Sensors and Systems in the School of Engineering, The University of Manchester, UK. His research interests span semiconductor materials, devices and technology, sensors and sensing systems for indirect imaging, as well as machine learning for sensor data processing. He has held research and academic appointments at several European Universities and has led the Publications and Education portfolios of the IEEE Sensors Council. He served as Expert Panel member in EVALNAT (2023-2024) and chaired one of the ICT Expert Panels, the Research Institutes Evaluation Committee and the National Evaluation Committee in EVALMIT (2024-2025).

Deborah Greaves

Deborah Greaves is a Professor of Ocean Engineering, Director of the Interdisciplinary Research Centre for Decarbonisation and ORE, Director of the COAST Laboratory and was Head of the School of Engineering, Computing and Mathematics (2016 -2022) at the University of Plymouth with previous appointments at the University of Oxford, UCL and the University of Bath. In 2020, she was elected to be a Fellow of the Royal Academy of Engineering and was appointed as a Member of EPSRC Council in 2022. She has led many national and international research projects concerning offshore renewable energy (ORE) in collaboration with industrial and academic partners, is Director of the EPSRC Supergen Offshore Renewable Energy (ORE) Hub. In the Queen's Birthday Honours List, 2018, she was awarded an OBE for services to Marine Renewable Energy, Equalities, and Higher Education.

Jan S Hesthaven

Since 2024, Jan S Hesthaven is the President of Karlsruhe Institute of Technology, Germany where he is also Professor of Computational Science and Engineering. Following his graduation from the Technical University of Denmark in 1995, he joined Brown University, USA where he became Professor of Applied Mathematics in 2005. In 2013 he joined EPFL, CH as Professor of Mathematics and, most recently, served as Vice-President of Academic Affairs until 2024. He is a recognised expert in the analysis and application of modern computational models for solving partial differential equations, including data driven methods. He is a member of the Royal Danish Academy of Sciences and Letters and was awarded an honorary doctorate from DTU in 2024 for his contributions to science and science leadership

Rebecka Jörnsten

Rebecka Jörnsten has been a Professor of Biostatistics and Applied Statistics at the University of Gothenburg since 2016. She obtained her Ph.D. in mathematical statistics from the University of California at Berkeley in 2001. She held an assistant and associate professorship at Rutgers University from 2002 to 2008, before joining the Department of Mathematical Sciences, University of Gothenburg in 2009. She has been vice-dean for research and research infrastructures at the Faculty of Science and Technology since 2018. Her research centres on model selection, neural network regularization, and developing new machine learning methods with applications to systems biology.

Claudio Mazzotti

Claudio Mazzotti is full Professor of Structural Engineering at the University of Bologna (Italy). He was the head of the Building & Construction Centre of Applied Research (CIRI-EC) of the University of Bologna. In 2024 he is member of the Board for the National Scientific Qualification within the Structural Engineering national group; he acted as international reviewer for a number of research projects funded by Italian and international bodies; he is author of more than 200 publications.

PM (Lina) Sarro

Lina Sarro, IEEE Fellow, is Professor in Microsystems Technology at the Delft University of Technology (TUD), the Netherlands. She received the Laurea degree in Physics from the University of Naples, Italy, in 1980 and a PhD degree in Electronic Engineering from the TUD in 1987. From 1981 to 1983, she was a post-doctoral fellow in the Photovoltaic Research Group of the Division of Engineering, Brown University, Rhode Island, U.S.A. Since 1987 she is associated with TUD where she became full professor in 2001. She is internationally recognized for her work on integrated silicon sensors and micro/nano-electro-mechanical (MEMS/NEMS) technology, for applications in health, environment, automotive and scientific instrumentation.

Bo Wahlberg

Bo Wahlberg has been the Professor of Automatic Control at KTH Royal Institute of Technology, Sweden, since 1991. He is an IEEE Fellow, an IFAC Fellow, and a Fellow of the Royal Swedish Academy of Engineering Sciences. His research focuses on decision and control systems with applications in industry and transportation.

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