The Research Council of Norway

Evaluation of Mathematics, ICT and Technology 2023-2024

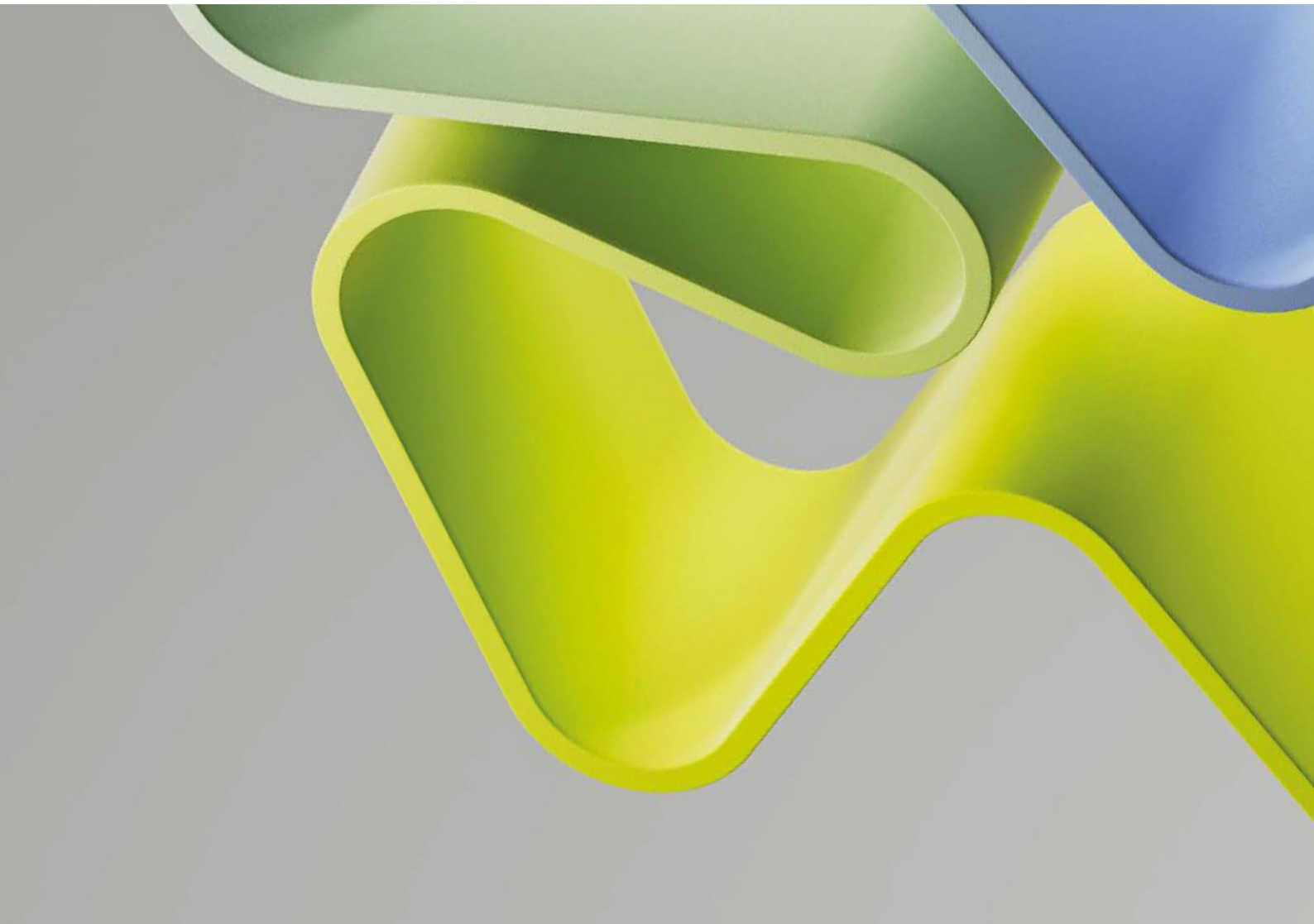
Evaluation Report for Administrative Unit

Administrative Unit: **SINTEF Energy**

Institution: **SINTEF Energy**

Evaluation Committee Institutes

December 2024



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Statement from Evaluation Committee Institutes

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

- NORCE Energy and Technology, NORCE Norwegian Research Center (NORCE)
- SINTEF Community, SINTEF Community
- SINTEF Digital, SINTEF Digital
- SINTEF Industry, SINTEF Industry
- SINTEF Energy, SINTEF Energy
- SINTEF Ocean, SINTEF Ocean
- SINTEF Manufacturing, SINTEF Manufacturing
- Norwegian Computing Center (NR), Norwegian Computing Center (NR)
- Energy and Energy Technology (ENET), Institute for Energy Technology (IFE)
- Simula Research Laboratory (SIMULA), Simula Research Laboratory (SIMULA)
- Human and organisational factors (HOF), Institute for Energy Technology (IFE)

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

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

The Evaluation Committee consisted of the following members:

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Description of the Administrative Unit

SINTEF Energy Research is one of six applied research institutes within Corporate SINTEF and is organised as a limited liability company. SINTEF Energy Research has four Research Departments: Energy Systems, Electric Power Technology, Gas Technology and Thermal Energy. 80% of SINTEF Energy's staff are research scientist, 70% of which hold a doctoral degree. Of the 222 research staff, 162 are research scientists, 25 are senior research scientists and 11 are chief scientists.

SINTEF Energy Research states that their main task is to support the realisation of the future sustainable energy systems in Norway, Europe and globally. They have identified ten main research areas, with their strategic priorities being renewable energy, decarbonised energy, clean industry and the integrated energy system of the future. Their strategy is based on market trends, political and strategic drivers, technological opportunities and the social mission of Corporate SINTEF. The majority of their annual income comes from collaboration with industrial partners on research projects, through which they can realise their strategy. SINTEF Energy Research's stated mission is "We shape future's energy solutions", which they state is integral to their strategy and their areas of research across their groups.

SINTEF Energy Research has extensive collaboration with public, private and research partners alike. They were instrumental in the centralisation of Norway's renewable energy effort under the RCN's RENERGI programme – now the EnergiX programme, and the Centres for Environment-friendly Energy Research under RCN. They collaborate extensively with NTNU, contributing to NTNUs research-based education, and share extensive state of the art research infrastructure and laboratories with NTNU. SINTEF Energy Research collaborate on a national, European and global level. Their collaborations result in a number of key impacts across research areas, to the benefit of industrial partners and society as a whole. This includes advancement in renewable energy technologies such as offshore wind (e.g. hosting FME NorthWind initiative) and hydropower. They also conduct research into entire value chain of CCS and host the Norwegian CCS Research Centre. They are also contributing to Norway's mission for zero-emission transport, by researching transport and energy systems, batteries and charging infrastructure. An example of this is SINTEF Energy Research's development of technology commercialised by Wärtsilä for wireless charging of the ferry MF Folgefonn.

SINTEF Energy Research identify several internal strengths that better position them for the future. These include their perception as an attractive employer, their collaboration with NTNU, their reputation within Norway and Europe and their presence in Brussels. In terms of external opportunities, they mention their leading knowledge required for the energy transition in the EU and closer collaboration with RTOs within the EU. In the future, SINTEF Energy Research wish to increase their visibility within the public societal debate and increase experience in their senior roles in case of adversity or the need to scale up/down staff and operations. In the SWOT analysis they also note uncertainties in national and international funding for research and development, especially in relation to political priority changes, as well as geopolitical instabilities and the possibility of cyberattacks.

Overall Assessment

The evaluation committee finds the unit well organised and aligned with the expectations of the green energy transition. The practices presented indicate a good level of organisation. The unit's research strategy has not been fully disclosed during the process, but overall, it shows good competences and good alignment for future topics. Its project portfolio is strong and rather industry focused. The unit's research infrastructures provide a strong basis for the activities. The unit shows a high relevance especially for industry, but also for national ecosystems and society in general. The impact cases demonstrate a good variety of actions, including long-term research that has resulted in concrete tools used in daily business, but also faster commercialisation and spin-off cycles for new research topics.

The unit operates with relatively low basic funding. At the same, the unit applies very lean practices and shows good efficiency and proper focus on research activities. The unit is strongly linked especially with NTNU but also other national universities and institutes. The unit is overall well positioned for EU level networks and projects; however, EU funding is an area that could be further improved.

Strengths:

The organisational structure and competences within research teams present almost a perfect match for cross-cutting energy system integration topics, when just integrated efficiently.

The unit has a very strong collaboration with industry and presents a strong industrial project portfolio. This indicates a strong relevance for the national ecosystem.

The unit has excellent research infrastructures, some of them operated together with NTNU for good efficiency. The unit has established clear practices on how to use the infrastructures for research and/or commercial activities.

The unit has very good mutual collaboration with NTNU through common projects, FMEs, networks and infrastructures, but including also personnel with shared roles, circulation of researchers, thesis works, etc. At the same, NTNU seems to be a good channel for recruiting new personnel.

The personnel are overall highly educated and competent. At the same, recruiting seems to be well managed and able to provide new competent people.

Weaknesses:

The unit operates with low basic funding, which sets some concerns on how competence development and capacity building can be maintained. At the same, how longer-term strategic viewpoint can be maintained in an independent manner given the strong focus on industry projects. The unit is anyhow well managing the situation and utilising national funding applicable for competence building.

The unit has surprisingly low share of EU-funded projects. Volume of EU funding is also stated as one objective. However, the unit does not indicate direct actions or plans to increase the EU activities. At the same, it is noted that the unit is well positioned to be more active within EU.

Even if strong collaboration with NTNU is an important asset, wider mutual collaboration schemes could be beneficial, especially internationally. Also, rather weak collaboration with certain SINTEF units like Industry or Community regarding energy projects was identified.

We believe that all organisations within SINTEF corporate can benefit from each other's research expertise and research infrastructures.

As a research institute with low basic funding, topics like personal development and learning, international mobility schemes, promotion of collaboration and overall assuring time and space for learning beyond projects can be challenging. However, the unit has proper practices in place.

Number of publications is a bit low, which can also be typical for research institute with industry-driven projects. Time and practices for publications within industry projects should be assured.

The table below addresses each of the questions raised by the admin unit in the Terms of Reference (ToR) for the evaluation.

Table 1 Evaluation Committee response to specific questions from the ToR

Specific request from the ToR	**Evaluation**
1. Scientific expertise suited to serve the market on the short and long term.	The unit presents good expertise that is suited to serve the market at the current situation, being also capable for cross-cutting systemic approaches required by green transition. Capability of maintaining this position in long term with the prevailing funding scheme was identified as one concern that need to be monitored carefully.
2. A project portfolio with a well-balanced mix of knowledge building projects and industrial innovation projects.	The project portfolio has a strong share of industrial-driven projects, which also indicates strong relevance of the research conducted. While the current mix is well balanced, it remains important to ensure enough resources for knowledge and competence building.
3. Proactive knowledge sharing through peer-reviewed publications and scientific dissemination to policymakers and the general public.	The unit shows strong societal impact through various different channels and has a good position in the national discussion. Publication activities could still be fortified, especially assuring more publications from industry collaboration projects.
4. Ownership and administration of necessary experimental and theoretical research infrastructure including excellent technical staff.	The unit holds modern research infrastructures and shows clear policies on running and developing them. The staff is clearly committed and trained for the research facility work. Balancing between experimental and theoretical infrastructures will be one key strategic choice for future.
5. Relevant cross disciplinary collaboration with other parts of the SINTEF organisation.	Statistically, the unit shows as most active internal buyer of work from other units based on whole SINTEF level data. However, at the same the unit does not show strategic integration with related SINTEF units like Digital, Industry or Community. Such cross disciplinary collaboration should still be improved.
6. Relevant collaboration with universities and other research institutes, particularly through participation in various centres of excellence and innovation (e.g., The Centres for Environment-friendly Energy Research (FME) and National Research Infrastructures) as well as EU projects.	The unit shows strong collaboration with other research actors. Domestic collaboration is dominated by NTNU, which is a strength but at the same time more diversity could be advisable. The unit has good presence in FMEs and uses them efficiently. The unit is also present in EU projects, however more EU participations is seen as one target.
7. Relevant national and international collaboration, e.g., Energi21, European Energy	The unit is involved in several collaboration networks. It is important to maintain the position and plan how to use the networks even more efficiently for establishing new EU projects and other initiatives.

Research Alliance (EERA) and SINTEFs Brussels office.	
8. Contribution to higher education in collaboration with partners from the HEIs.	Contribution to higher education is limited. The unit is mostly collaborating through master's and doctoral education, as well as with joint projects together with universities. Beyond this, information on HEI contribution and collaboration is quite limited.
9. Relevant and sought-after collaboration with industry, giving documented impact.	The collaboration with industry is very strong, and industry-driven projects are showing strong relevance of the work done. The unit has a good impact on society, which is also demonstrated by the impact cases.
10. Innovation creation addressing major societal challenges.	The unit has a solid background on technical research, often with industry that is directly commercializing the outputs of the research. However, the unit lacks own innovation in driving research into results and towards societal benefits. Mechanisms promoting innovation should be further developed.

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

Recommendations

Certain recommendations on how to improve the performance and develop research strategy have been defined as follow. More detailed recommendations are also given in the forthcoming chapters.

1. Ensure efficient internal collaboration for cross-cutting topics of the future. The unit is well positioned when being able to integrate different competences.
2. Ensure resources for knowledge building and competence development in addition to the industry-oriented project work. At the same, maintain independent long-term vision that is not too strongly steered by industries.
3. Assure resources for knowledge building, personal development, learning, international exchange, etc. on the side of industry-driven project portfolio.
4. Increase the share of EU funding and assure necessary self-funding shares. Take more systematic approach on EU programs: allocate persons or roles, name grant writers and coaches, etc.
5. Find the strategic partners on EU and global level and build mutual connections and joint collaboration agendas, not only through specific projects.
6. Assure enough time for publications within industry projects and assure proper joint publication practices with industry partners.

1. Strategy, Resources, and Organisation of Research

SINTEF Energy is a wide-scoped research institute focused on several aspects of energy systems. The institute has a strongly project-driven approach and close collaboration with industry. The unit shows a good level of preparedness and relevance for the green transition and capabilities for cross-cutting energy transition topics.

1.1 Research Strategy

The unit's stated mission is "We shape the future's energy solutions". Its main task is to support the realisation of the future sustainable energy system in Norway, Europe and globally. The unit focuses strongly on contract-based applied research, for which it states to have an efficient business model. Operations are also stated to have good economic basis.

The unit's research strategy is not disclosed in detail as it is stated that the actual strategy is internal only document. This makes the assessment more challenging. The higher level SINTEF strategy applies also to SINTEF-Energy and shows good higher level alignments.

The unit is organised as ten research areas categorised according to substantial topics which is overall a reasonable approach. The division of substance topics is rather traditional, defined following specific technologies or energy system levels. It must be noted that latest trends in the energy transition include cross-cutting topics like sector integration and power-to-x, which may be difficult to directly locate in dedicated teams within this structure. There might be a risk of too scattered approach and even internal competition for new cross-cutting topics. On the other hand, when collaborating effectively, these research areas can address all such new phenomena nicely.

The strategy is mostly realised through project work. Project development by individual researchers, groups and departments is stated as a means for implementation, however there are not many details on how this works in practise. Overall, it remains bit unclear how adequate knowledge building and competence development can be maintained with such a strong focus on industry projects, and how the unit is able to maintain enough independence and longer-term strategic views in case the industry needs are very concrete.

Recommendations to the administrative unit.

- Ensure efficient collaboration for cross-cutting topics of the future
- Ensure resources for knowledge building and competence development in addition to the industry-oriented project work
- Ensure independent long-term vision that is not too strongly steered by industries
- Maintain strong role in national research agenda, and fortify the role in EU arenas

1.2 Organisation of Research

The organisational structure is typical and well defined. There are four research departments with research groups below them. Research director leads each department, and each research group has a research manager. It is not fully clear how the 10 research areas to be assessed are located within this organisation.

All research is organised strongly within projects running contract research. Each project has an allocated project organisation which can also combine teams and departments. Communication activities are stated to be close to research activities. The degree to which the projects combine competences from different areas remains bit unclear, as well as how this matrix structure supports uniform workloads – and overall, how evenly the workload can be shared at the moment. Also, how important indicator is the utilisation rate of personnel, and on which level is this monitored?

A strong collaboration with NTNU is visible. There is active staff exchange/sharing between the units. Also, research infrastructures are shared which is definitely good approach.

Specific objectives like knowledge building, innovations or commercialisation are supported by specific project types suitable for the actions needed. Again, all actions need to be taken within these funded projects. It is bit unclear how they are actually funded. Since the basic funding is low (7-8%), certain funding mechanism is needed. Overall, concerns on how well the unit can look into far future and enter into fully new areas and expertise with the current funding structure can be presented.

The strategies for researcher training and outreach are quite briefly described and do not offer much concrete information. SINTEF level practices apply also here and are well defined.

Recommendations to the administrative unit.

- Ensure best possible use of resources for cross-cutting topics – at the same, maintain equal share of work among researchers
- Assure enough budget for knowledge building, innovation and commercialisation projects
- Monitor the utilisation of the researchers on a proper level

1.3 Research Funding

Overall, the unit's income has shown a good annual growth of 5-10% annually over the last years, reaching 523 MNOK in 2022. A good share of funding comes directly from industry. This gives the unit a good position even in case of reductions in public funding. In addition, national funding has an important role.

Share of EU funding is surprisingly low, below 10%. It is stated that EU share has been growing and there are plans to increase it further, but no direct actions are mentioned in the self-assessment report. It is also mentioned that EU share will increase as the level of national funding decreases, which could be understood to mean that priorities and resources are still more towards national funding applications. The admin unit should make clear, dedicated actions towards supporting the development of successful proposals for EU funding.

Given the low basic funding, it is unclear how the unit is able to cover their own funding share which is typically ~30% in EU projects and can become quite heavy cost in case of big EU portfolio.

The base funding for the institute is low, though this is in line with RCN funding for other research institutes. This leaves the evaluation committee with some concerns on how strategic development of the organisation and competences can be facilitated.

Recommendations to the administrative unit.

- Maintain strong position with industry funding
- Increase share of EU funding, and assure necessary self-funding shares
- Take more systematic approach on EU programs: allocate persons or roles, name grant writers and coaches, etc.
- Include young researchers in EU project preparations actively, so that they will learn the process. Allocate actual preparation work widely to make it part of the organisational culture.

1.4 Research Infrastructures

Presence in national infrastructures is strong, including also ECCSEL which is part of EU ERIC scheme. The key infrastructures are well positioned for the focus of the unit.

Accessibility of infrastructures is supported by mechanisms like web pages for information, booking systems, etc. The actual results or KPIs regarding co-use of infrastructures are not provided.

Systems for using the infrastructures both for research and more commercially oriented actions, while having public support for them, have been established, but no further details are given. This is typically a challenging point for infrastructures receiving public funding so proper measures are important.

Recommendations to administrative unit.

- Keep clear practices for research and commercial activities occurring in same infrastructures.

1.5 National and international collaboration

National collaboration is extensive. Collaboration with industry is clearly an important strength of the unit. Also, public sector and societal impact seem to be well addressed.

A strong collaboration with NTNU is present, though the self-assessment report does not present much collaboration with other universities within Norway. Other SINTEF units are also presented as crucial partners. Several universities or research institutes are also listed. Some companies are also listed among Top 10 national collaborators.

Several FMEs (Centres for Environment-friendly Energy Research) are mentioned, but there is no systematic presentation of participation models within these FMEs.

Internationally there are good linkages with strong research institutes in Europe and globally. Many of them seem to be based on individual projects rather than other mutual collaboration schemes. Some (the links with Berkeley University for example) indicate staff exchange and maybe more strategic collaboration beyond individual projects. Networks like EERA and CIGRE are highly valuable and also a good means for improving the EU funding situation.

Recommendations to administrative unit.

- Expand nationally also beyond NTNU
- Find the strategic partners on EU level and build mutual connections and joint agendas, not only through projects

1.6 Research staff

For the reporting period, the unit had bit less than 350 researchers. Personnel are very highly educated; around 70% having a PhD degree. Share of support and administrative functions is nicely low compared to research staff. Gender balance is bit challenging, although there has been clear improvement during recent years. This is clearly acknowledged, although no direct actions are mentioned.

Overall, a good proportion of researchers are in their earlier career stages (75% of researchers being below senior and chief scientist levels), which sets a promising outlook for future. At the same, this can become a challenge as there is definitely a need for young experts everywhere in the society currently, and recruiting new competitive people can be challenging. This is also acknowledged by the unit.

The description of research career opportunities in the self-assessment report is quite generic. Most learning should take place within projects, and further education is encouraged, however the descriptions on how this can happen are short. The personal development plans and appraisals process is rather typical for an institute such as this. The SINTEF School is interesting development, however there is not much information given in the self-assessment report about what this provides, and it seems to offer generic training on whole SINTEF level.

Using 70% time on research projects is a reasonable and sustainable level, allowing time also for development. It is unclear from the self-assessment report whether the 30% can be supported internally or whether this should also take place within the (mostly commercial) projects. Doctoral education is supported, but no information on how this can be done is provided; whether there can be financial support / time offered for completing the thesis etc.

For researcher mobility, the admin unit presents some good examples, but there is no indication of systematic mobility plans for young researchers or on how mobility could be integrated into personal development plans. Though the evaluation committee acknowledges that it may be this is just not documented in the documents provided for the evaluation.

Recommendations to the administrative unit

- Remain active for young experts' recruitment
- Include a more systematic mobility plan as a part of personal development plan: expect abroad periods, which must however be supported by the projects
- Enable the personal development time

1.7 Open Science

Overall, the unit applied SINTEF standards which are generally high and in good shape.

Peer-reviewed articles are nicely published through open access channels. Of the publications, 50.4% are archived and 16.2% are available under Gold Open Access.

Recommendations on how to promote open science

- Support publication of research generally, as the average numbers are low.
- Assure enough time for publications within industry projects and assure proper joint publication practices with industry partners

2. Research production, quality and integrity

As described earlier, the research is focused around 10 main research areas that can truly build an extensive entity for the needs of energy transition. These areas include smart grids, power transmission, integrated energy systems, offshore wind, hydrogen, energy efficiency, carbon capture and storage (CCS), hydropower, bioenergy and zero-emission transport. These areas form a good entity altogether. For the nature of sector-integrated and cross-cutting future energy system, it will be crucial to be able to combine competences across these research areas in an agile way.

Considering the research areas in more detail, it can be summarised that smart grids and power transmission focus strongly on systemic electrification of society, whereas offshore wind and hydropower focus on renewable electric generation. More cross-sectoral perspective is brought in by integrated energy systems, energy efficiency and bioenergy in the form of heat systems, and by zero-emission transport in the form of transport. Hydrogen addresses the important potential of hydrogen economy and supports application areas like transport and industry. CCS is also very important area especially for Norway, but it is slightly less integrated with other research areas especially if CCU is excluded.

Looking at the overall entity, the key question is how easily this structure can address highly cross-cutting needs in the future. Looking at the descriptions, it seems that the integrated

energy systems team could have an especially important role in coordinating, but the organisation needs to support and steer towards efficient collaboration across the areas.

The evaluation committee make the following further reflections on the structure and distribution of work within the admin unit:

- Energy storage seem to be distributed across the admin unit, and not clearly assigned to certain team
- Smart grid, power transmission and integrated energy systems have certain level of overlapping regarding topics like flexibility
- Related topics like energy markets, regulation, business models are not very visible, although surely covered on project level
- Role of individual citizens/users is not very visible. This could be realised through energy use in buildings, potentially together with SINTEF Community
- Role of new enablers like AI, edge computation, cybersecurity are not very visible, but on the other hand they must be seen exactly as tools rather than purposes. Collaboration with SINTEF Digital could be beneficial.

2.1 Research quality and integrity

For research quality and integrity, the self-assessment report raises exactly correct concerns. Given the strong focus on industrial projects, these aspects can become challenging. It is also evident that there are differences between research groups, as some of them are more focused industrial projects and some have more research orientation in their project portfolio.

For the quality, expectations from industry projects can require fast results, and in some cases also more practical results than high-quality scientific research would imply. Maintaining the level of quality may be demanding. Mostly indicators for good quality are described, however actual measures are lacking.

For integrity, the concern of biased research can become relevant. With strong industry collaboration, there may be interests on affecting the results and their publication. Overall IPR aspects can be limiting the publication possibilities. These risks are probably noted, and it is stated they are covered while signing contracts with clients. Actual support for individual researchers is not described, although it could be very necessary especially for younger researchers.

A further integrity question can also be how the unit handles discrimination of industry R&D versus testing services within the research infrastructures, as this tends to be a grey zone where alignments are not very clear.

Average number of publications per researcher (1.14 per researcher per year) seems bit low. The bibliometric analysis for the unit presents that the unit has produced 234 publications in 2022. The citation impact for these publications is at a level that is expected for an organisation like SINTEF Energy – 7% of publications are in the top 10% share of publications.

Research group Insulation systems overall assessment

The diversity of competences of the group personnel enriches the group's interdisciplinary approach and ensures its attractiveness as a partner for diverse types of projects. The laboratory and other resources necessary for performing research activities available for the group are of a high international standard. This way the group has the continuing ability to

attract long-term financing for national and international cooperations, both in knowledge building and in industrial innovation areas. The group also uses in its activity external academic competences, mainly from NTNU, and offers in return their own support in form of co-supervision of PhD students. The strength of Insulation Systems research group is broad scientific expertise and international reputation in the field of high voltage technology. As the group works based on both industrial and public fundings, a fair part of its research is therefore confidential, and its quality cannot directly be evaluated. One may anyhow assume it is high as the industrial partners keep supporting it. The publishable part of the group research output is of high quality, disseminated through highly recognised international scientific journals and publications of international professional organisations. It until recently mainly concentrated on research related liquid insulation systems, though attempts to open new research areas can be noticed, like technologies of power storage devices (batteries) and high voltage direct current (HVDC) transmission. A noticeable weakness in the group's activity can be spotted in the gradual drop in its financing condition. During the period 2018-2022 budget figures of the group dropped by about 40%, with a significant rise of the basic funding. The funds have been obtained from industry and other private sector sources, from NRC and from SINTEF Energy's basic allotment. In 2022 the respective contributions accounted for 47%, 42% and 11% of the total group's funding.

Research group Offshore energy systems (OES) overall assessment

The research group has an outstanding structure and composition to conduct excellent research activities. The research group is led by a very qualified leader, who has skills to manage the group's affairs internally and externally at the until level. The group organisational environment is very strong for supporting the production of excellent research. The research group does not have a clear focused detailed strategy for its recruitment strategically, and internationalisation. The research group should have more detailed strategy regarding the future group growth. The research group has general mobility opportunities for group members but not detailed. The host organisation supports the research group with basic funding around .8% of the total funding. This is a not significant, but it is acceptable due to the business model structure of the research institutes. The research group was very successful in attracting external funding over the five years between 2018-2022. The administrative unit provides adequate resources, including personnel, facilities and infrastructures, to the research group. The research group facilities and infrastructures are outstanding, and the group is co-managing the national smart grid laboratory with NTNU. The research group has been involved significantly in industrial, national and international projects with leading and participating roles, but their involvement in EU programs is not as a leading partner, which is a key element for the future growth of the group to be recognised as a world leading group. The quality of the research is internationally excellent. The research is clearly of an international standard, with a very good level of quality in terms of originality, significance, and rigour. The research group has contributed extensively to economic, societal and cultural development in Norway and internationally. This is evident through their involvement in industrial-oriented research (e.g. NOWITECH project), public engagement with different audience, academic collaborations (e.g. NorthWind project), and joint research projects nationally and internationally. The research group has an outstanding research group's societal impact, which can be confirmed via their list of user-oriented publications and products including patent, and open access innovative software (e.g. TOPS, PowerGIM, etc.). However, there are some concerns regarding the societal contributions from all group members. The main contributions have been delivered only by few members.

Research group Active Distribution Systems (ADS) overall assessment

ADS group stands as a leader in the Norwegian energy research landscape, with recognition for their contributions to advancing active distribution systems. While their achievements in securing funding, industrial collaborations, and societal impact are commendable, there is room for improvement in elevating the quality and quantity of their scientific publications to further establish their prominence in the field. In fact, despite the funding availabilities and both academic and industrial collaborations, their research output, while good, falls short of expectations in terms of top-quality and seminal scientific publications in world-leading journals. In an international context, ADS group maintains a good reputation, particularly within the European energy research community. Their effective collaborations and contributions to innovative research projects position them as important contributors in power system and cyber-physical systems community. With continued emphasis on enhancing research output quality and international visibility, ADS is poised to further solidify its standing as a prominent player in the energy sector, in line with their goals and ambition.

Research group Bioenergy (BIO) overall assessment

BIO has a very broad range of core research fields. The group includes 12 persons (researchers, with a very good gender balance). However, the specific research goals of the group are not very clearly defined; What and why are BIO working with exactly these activities? The group has a documented, solid organisational environment for supporting the production of high-quality research. BIO has good funding (including national funding, RCN funding, industrial funding, and a minor international funding). The group also have a good balance between funding and activities. BIO has a well-documented project portfolio, including many projects with good funding. BIOs societal contribution is very good, in the sense that they host several blogs, webinars, podcasts etc. Anyhow, the direct interaction with society questionable, and not very well documented, in the self-assessment report. Some sort of monitoring data on the feedback on these blogs and webinars, would be nice to see as part of the documentation.

Research group Energy Processes (EP) overall assessment

The group has a clearly defined research area as well as a well-defined strategy process. The report clearly describes a managerial focus on the strategy of the group beyond the day-to-day management of the group. Some of the benchmarks are difficult to measure (e.g. it mentions “similar research groups” but does not stipulate which research groups that are being used as a comparison).The group is very strong on attracting funding and when you in addition look at how funding is converted to academic publications there is a clear line between research funding and research publications. In addition, the funding is spread over multiple instruments. Concerning the societal impact dimension, the research group has a range of important contributions. The topics are societal important topics like e.g. carbon capture and storage. Therefore, much of the applied research almost automatically has a societal angle. Consequently, there should be a possibility for the group to engage more in the public debate, in community discussion to disseminate the strong research-based knowledge to the broader public. In addition to this, a strategy on how to work with universities and define instruments and the resources put in and the expected gain should be part of the group discussions.

Research group Thermodynamics (Thermo) overall assessment

The THERMO research group's focus on the safety and economics of CCS holds paramount societal significance, not only for Norway but also for the global effort to combat global warming. Additionally, the group's contributions to the development of knowledge on the

large-scale transport of renewable energy from Norway, particularly in the form of liquid hydrogen, have garnered international recognition and are crucial for the nation's transition toward clean energy. The group has published its findings in renowned international journals, and prestigious conferences and organises workshops to position itself as a technology leader in the field of CCS and hydrogen. The research group is not involved directly in teaching but is involved through supervision and collaboration with master's and PhD students. To ensure a consistent inflow of talent, the group has forged solid collaborations with key research groups at NTNU. The societal impact is linked to the advancement of knowledge related to emerging energy resources and environmental issues. This option is mandatory for future development of Norway and for Europe. The Thermodynamics group could be then a focal point for the formulation of informed policies and decisions by stakeholders. The group provides support for policies and regulations at both national and international levels, offers opportunities for master's and PhD students to advance their research, and undoubtedly contributes to Norwegian society in the field of CCS and in the transition to green energy production and delivery. However, it's recommended that a greater effort be made to reach a broader audience, including through public initiative.

3. Diversity and equality

Overall, diversity and equality strategies of the admin unit rely on SINTEF level guidelines which are extensive and up to date. The alignments and objectives described are proper and address the right needs. No detailed information on means and processes of these principles in daily activities is presented in the documentation, but overall, it seems these aspects are properly managed based on higher level guidelines.

4. Relevance to institutional and sectorial purposes

The unit has a strong role in setting the national research agenda and development paths. The unit has been a driving force behind extensive national programmes, also leading an established entity where industry, research and public sectors jointly define future strategies. Reference is made to studies showing that these programs have generated real value for society.

Given the contract-based research nature, many innovations and developments are directly commercialised through client companies. In addition, there is a dedicated organisation on SINTEF level for commercialising innovations.

Innovation has also been a clear expectation for FMEs.

Bringing innovations towards commercialisation is stated to be supported at the unit, but there are not many details on how this can concretely be done, and what are the forms of support for individual researchers. Division of gained profits is not fully defined in the self-assessment documents. Overall, it is bit unclear to the evaluation committee how rewarding versus demanding such processes is for the researchers involved.

The unit is actively contributing to policy development and societal discussion through several channels, including national initiatives, committees, collaboration networks and events. This is overall well addressed in the self-assessment report. Involvement of end users is obvious given the format of contract research and the high share of funding coming directly from industry.

5. Relevance to society

The unit has a strong potential for showing good relevance to society. The example cases that build on decades of high-level research within the unit and have resulted in concrete tools or methods that are used by industry are especially impressive. There are also examples of quicker commercialisation and spin-off actions with more fresh research results. This is also important way of assuring relevance for the society and indicates a good innovation potential.

The unit has a good position in the national research roadmap and has an on-going collaboration with industry, which helps to maintain relevance. Position on EU level is more unclear, even though the unit has a dedicated EU office in Brussels and some important networks are mentioned. More systematic presentation on EU-level presence could be useful.

The topics addressed by the unit are highly relevant. One concern the evaluation committee have is around how agile the unit can be for cross-cutting topics like power-to-X that will require actions across research departments and teams.

5.1 Impact cases

Comments to impact case 1: SHOP – short-term planning of hydropower production

The case presents a software tool for optimising hydropower production. It is stated to enable a 2% increase in the value of hydropower production. The software includes advanced algorithms that utilise information on water flow, market price and loads.

The case has a strong history within the unit. Hydro scheduling tools have been developed for more than 50 years, and the development of SHOP tool has also been active over decades. First prototype was made in 1989, first ready version was delivered in 1996, and the tool has been updated constantly with complete redesigns conducted in 2008 and 2016. SHOP is used widely by national and foreign hydro producers.

The topic has been developed with highly committed group, as it seems that almost all researchers are still present at the unit.

The case addresses a topic that is gaining even more importance as the power market becomes more dynamic. SHOP is used in a significant number of installations, optimising 60 GW on a daily basis. This is roughly 4.5 % of all global capacity, which is also a good share.

This case demonstrates research-based commercialisation at its best: offering a concrete tools that is based on decades of research and is continuously improved, yet with a good societal impact.

Comments to impact case 2: Use of natural refrigerants if refrigeration and heat pumping systems

The case presents research activities for integrated cooling, heating and ventilations systems used in supermarkets. The research has a long tradition, ranging from late 1980s. Specific FME HighEFF has taken this topic significantly further.

The contribution has been especially for using CO2 and other refrigerants. Research has covered fundamentals of fluids and heat transfers, component level and integration to different applications.

The research has been conducted with a committed research group, many of the researchers still being present in the unit or in partner organisations.

In this case, it is especially positive that the development has been boosted again by the FME (2017-2024), which has also updated studies on impact potential of the solutions. The impact can be huge; 35% energy savings, 650 million NOK annual savings, significant emission reductions.

Overall, this case presents nicely the importance of continuous high-level research and close collaboration with industries and users. Even though the results have not been directly productised, they have obviously created societal impact and enabled higher-level objectives.

Comments to impact case 3: Enabling low-pressure transport of CO2 by ships

This case presents research on CO2 liquefaction and transport. There is a long track record for developing models for these aspects. These models have further enabled assessment of different transport options, and also indicated low-pressure transport as most cost-efficient option. In addition to modelling, experimental work has been carried out to support the research. Overall, the solution is close to market maturity currently.

The model suite includes several highly sophisticated and detailed models for different purposes. They have been used for optimisation challenges. The models have also helped to evaluate certain risks that have been raised.

The whole research is based on several projects, including both EU and national projects, and was brought together by FME called NCCS.

The work has been taken by a rather large group of researchers. They are mostly still with the unit, also indicating high commitment to the topic.

The solutions developed can decrease the CO2 transport costs by more than 30% depending on circumstances. At the same, relevant risks have been mitigated with the gained knowledge.

Comments to impact case 4: Cost-effective energy storage systems

This case presents the development of Phase Change Materials (PCM) as thermal storage units for both heating and cooling purposes. Compared to previous cases, this is quite fresh and new research carried out since 2017. A public research project started the research and a FME called HighEFF contributed to the topic as well. Another national project was started later and is still ongoing.

The research has been conducted in collaboration with NTNU. Pilot has been running since 2021 and providing practical experiences. The results included look promising.

This case has lot of potential but seems it is still in the development phase. The specific strength of this case is in quick development, commercialisation and setting a spin-off company for the topic. This shows excellent innovation and start-up thinking.

Comments to impact case 5: Groft design – software enhancing the powergrid

This case presents a software tool that can increase the capacity of cable transmission grid. The research behind is relatively new, starting around 2015. Two projects have been taken to develop FEM modelling and graphical interface for high voltage cables. The methodology has some benefits that have been published in scientific publications. A pilot site has been built to test the methodology in real circumstances.

The case has been commercialised into a software product with a relatively fast process. The software is stated to be now in use by grid operators and consultants, however no supporting figures on how wide the use is are given. The method can improve transmission capacities by 5-20 %, which is important within current green transition phase under which grids are facing increasing loads. The monetary benefit can also be significant.

This case shows a good potential for wider impact. At this point, the main strength can be seen within the process of quick commercialisation and collaboration with partners.

Methods and limitations

Methods

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

The documentary inputs to the evaluation were:

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

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

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

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

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

Limitations

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

List of administrative unit's research groups

Institution	Administrative Unit	Research Groups
SINTEF	SINTEF Energy	Insulation systems Bioenergy (BIO) Offshore energy systems (OES) Energy Processes (EP) Active Distribution Systems (ADS) Thermodynamics (Thermo)

Terms of Reference (ToR) for the administrative unit

The CEO of SINTEF Energy Research mandates the evaluation committee appointed by the Research Council of Norway (RCN) to assess SINTEF Energy Research based on the following Terms of Reference.

Assessment

You are asked to assess the organisation, quality and diversity of research conducted by SINTEF Energy Research and its nominated research groups 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 aspects in your assessment:

1. Scientific expertise suited to serve the market on the short and long term.
2. A project portfolio with a well-balanced mix of knowledge building projects and industrial innovation projects.
3. Proactive knowledge sharing through peer-reviewed publications and scientific dissemination to policymakers and the general public.
4. Ownership and administration of necessary experimental and theoretical research infrastructure including excellent technical staff.
5. Relevant cross disciplinary collaboration with other parts of the SINTEF organisation.
6. Relevant collaboration with universities and other research institutes, particularly through participation in various centres of excellence and innovation (e.g., The Centres for Environment-friendly Energy Research (FME) and National Research Infrastructures) as well as EU projects.
7. Relevant national and international collaboration, e.g., Energi21, European Energy Research Alliance (EERA) and SINTEFs Brussels office.
8. Contribution to higher education in collaboration with partners from the HEIs.
9. Relevant and sought-after collaboration with industry, giving documented impact.
10. Innovation creation addressing major societal challenges.

In addition, we would like your report to provide a qualitative assessment of SINTEF Energy Research 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
- strategies from SINTEF and SINTEF Energy Research

Interviews with representatives from the evaluated units

Interviews with SINTEF Energy Research 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 SINTEF Energy Research 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 SINTEF Energy Research and RCT. SINTEF Energy Research 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 CEO of SINTEF Energy Research and the RCN no later than two weeks after all feedback on inaccuracies has been received from SINTEF Energy Research.

Appendices

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

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