

Evaluation of the INFRASTRUKTUR initiative as a funding instrument

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Preface from the committee

Research infrastructures (RIs) are advanced and extensive tools for research, ranging from large single physical facilities and advanced instruments to distributed e-infrastructure tools and common research databases. RIs enable groundbreaking science, drive advanced method development and innovation and have a large long-term impact on society, both in Norway and the rest of the world. A fundamental property of RIs is that their use, and often also their operation and funding, is shared by several research groups, institutions or industries, or countries.

The Norwegian INFRASTRUKTUR initiative has been instrumental in the Norwegian development of national advanced RIs spanning most disciplines and also for involvement in leading international, mostly European, RIs. In a few cases Norway has even developed international leadership.

The INFRASTRUKTUR initiative was launched in 2009 and has since then expanded and evolved in stages. In 2020, the Research Council of Norway (RCN) invited an international Evaluation Committee to assess the initiative.

The evaluation committee received a comprehensive portfolio report on the INFRASTRUKTUR initiative from the RCN. This report together with fact sheets and user surveys of the individual RIs, self-evaluation reports by the RIs and questionnaires from institutions responsible for funded RIs (universities and institutes), constitute the main written sources for our report. The committee has also had access to several other reports, evaluations, and other complementary information from the RCN. The written information was supplemented by interviews with RI managers and research users of the RIs, management from universities and institutes as well as staff at the RCN. A general high quality of the reports and a high level of enthusiasm and cooperation from the various stakeholders during the interviews and other interactions strongly contributed to and facilitated the committee's task of producing a comprehensive report.

We initiated the assessment in May 2020 and delivered the final report in April 2021. Thus, the evaluation of the INFRASTRUKTUR initiative took place entirely during the Covid-19 pandemic, and all meetings and interviews therefore had to be done using digital video-conferencing. This generally worked very well due to the recent rapid evolution of digital conferencing tools, good planning and not least the fact that all involved have had considerable experience and training in the use of digital meetings.

We would like to thank the RCN staff responsible for the INFRASTRUKTUR initiative, Solveig Flock, Odd-Ivar Eriksen, Herman Farbrot, Kirsti Solberg Landsverk, Christine Daae Olseng, Helene Sophie Aanerud and Kristine Brekke Harrison who have always been helpful, professional and friendly in their interaction with us.

Thanks also to the RI management, vice-rectors, pro-rectors and deans for taking the time for the interviews and for the constructive dialogue about the INFRASTRUKTUR initiative and Norwegian research. Your remarks are highly appreciated. Thank you to former RCN Chief Executive John-Arne Røttingen and the Board of the RCN for the opportunity to evaluate the impressive Norwegian INFRASTRUKTUR initiative.

As Chair, I would like to thank the other members of the evaluation committee for a competent, professional and engaged collaboration; Dr. Paolo Budroni, Vienna Technical University, Austria; Director Olivier Lefort, Ifremer, France; Prof. Riita Majala, Academy of Finland, Finland; Prof. Barend Mons, Leiden University, The Netherlands; Prof. Åsa Von Schoultz, University of Helsinki, Finland; Assistant Director Katrine Vinnes, The Federation of Norwegian Industries, Norway. I would also like to thank the Secretary to the evaluation committee, Dr. Leif Eriksson, for professional and skillful organization of meetings and interviews, as well as for the drafting and editing of the report.

In this report, the committee presents its analysis, main conclusions and recommendations for the development of the INFRASTRUKTUR initiative. The final version of the report has been read and approved by all committee members.

Prof. Lars Börjesson

Chalmers University of Technology, Sweden
Chair of the Evaluation Committee

Executive summary

The main conclusion of this evaluation is that the Research Council of Norway's (RCN) National Financing Initiative for Research Infrastructure (INFRASTRUKTUR) is a success and has a significant impact on the Norwegian research system. The evaluation committee strongly recommends that the initiative be continued as the main mechanism to support investments in national and international research infrastructures (RIs).

RCN's INFRASTRUKTUR initiative was established in 2009 to fund investments in RIs nationally and internationally. The initiative was the result of the Norwegian government's response to the rapidly increasing importance of RIs, expressed in the white paper for research in 2009. Its overall objective is to ensure that the Norwegian research community, as well as society and industry, has access to relevant and up-to-date RIs that facilitate high-quality research for an innovative, sustainable society and that help address the knowledge challenges facing society.

RCN decided in 2019 to evaluate the INFRASTRUKTUR initiative as a funding instrument with a view to shed light on how well the initiative helps to achieve the objectives, assess the added value of funding RIs through the initiative, and to further develop the scheme. An international evaluation committee was set up to assess the following areas:

- Impacts of the initiative on research and the research system
- Benefits to society from the RIs that were granted funding
- Organisation of RIs that are granted funding
- Organisation of the National Financing Initiative for Research Infrastructure

The committee analysed a wide variety of background material provided by RCN and interviewed key stakeholders, including RI managers, university and institute managements (vice-rectors and deans), users of the RIs and staff members at the Department for Research Infrastructure at RCN. Because the evaluation was conducted during the Covid-19 pandemic, all interactions with stakeholders and between the committee members had to be performed digitally, mostly by video conferencing.

The evaluation committee is grateful to the RCN staff and all the stakeholders for the high quality of the material they provided and for sharing their time, interest and knowledge which made the interviews such a valuable contribution.

This evaluation, like most others, has its limitations. An obvious one is the challenge of firmly establishing causality between the investments in RI and the impact on research quality and society, given the lack of simple and straightforward performance metrics. We have tried to overcome these limitations by applying the committee members' combined experience of various research systems when analysing the various sources

of information, including statements made during interviews and in written reports.

In comparisons with other ways to organise RI funding, the committee finds the Norwegian research system rather unique in several ways. It is uncommon to have such an initiative embedded in a research council that covers all areas of research and innovation. The approach to funding and organising RIs is also unusual in the international context, particularly with regard to the clear division of roles between RCN and the research performing organisations (RPOs, mainly universities and research institutes). RCN's INFRASTRUKTUR funds are primarily intended for high-priority and competitive investments in new national RIs or major upgrades based on research community needs, whereas the RPOs have full responsibility for operating the infrastructures, including operating costs and making them openly available to Norwegian research communities.

This evaluation aims to provide answers to the following questions: 'What is the value of RCN's INFRASTRUKTUR initiative for Norwegian research and for society?' and 'Can it be improved in some way with regard to society's future needs for research?'

The short answer to the first question is that in its first 10 years the initiative is a successful game-changer that has already provided Norwegian research with new or upgraded RIs of a high international standard, and has had a strong impact on the research conducted by RPOs as well as on international research cooperation. The INFRASTRUKTUR initiative is also an important early driver and enabler of FAIR (findable, accessible, interoperable and reusable) data, which is of immense importance for more effective research and use of data in society and in industry. It has also begun to demonstrate positive effects on society in the form of increased use by industry, increased university–industry interactions and important advances in crucial areas such as climate, health, sustainable energy and social welfare. The latter effects are generally long-term and are expected to increase over time, contingent on continued upgrades and new infrastructures that fulfil the needs of forefront research.

In response to the second question, the committee finds that the INFRASTRUKTUR initiative is well organised and excellently managed, with the respective roles of the actors in the research system clearly defined. However, research and its contexts are constantly developing, and we have identified some challenges to the initiative and made recommendations on how to handle them. The main recommendations are summarised below. A more detailed account of the challenges and recommendations is presented in chapter 5 of this report.

In July 2019, a set of ArcticABC Development ice tethered observatories (ITOs) was deployed from R/V Kronprins Haakon in the Arctic Ocean drift ice ecosystem at about 84°N. The ITOs followed the drifting sea ice to the north of Iceland providing time-series of e.g., phytoplankton biomass, bioacoustics of the water column, physical and chemical characterisation of the water, as well as properties of the ice itself.



Photo: Kunuk Lennert (UiT)

The evaluation committee's most important recommendation is that the INFRASTRUKTUR initiative should be continued as the main mechanism to support investments in national RIs and in Norwegian nodes in international RIs. The size of the initiative should be balanced between the need for investment in RIs (through RCN) and the ability to fund operations (through users and RPOs).

To further improve the INFRASTRUKTUR initiative and for RCN to continue to be a highly trusted partner in the future strategic development and decision-making process, we recommend that RCN:

- introduce landscaping activities to consolidate a 15-year vision and projection of the financial needs for new investments and upgrade of existing RIs;
- further develop the RI roadmap to address international developments and trends in RIs more efficiently as well as opportunities for and threats to Norwegian research, society and industry. We further suggest that the roadmap be used to more clearly identify areas that need further support to maintain or enhance competitiveness related to, for example, green economy and digitalisation;

- develop different sets of well-designed indicators of success (key performance indicators (KPIs) and/or metrics) and continuously monitor in accordance with them;
- ensure that the costs of using RIs are systematically included in R&D project applications across all national research initiatives and portfolios administered by RCN;
- carefully consider how the strategic criteria used in the second strategic/administrative part of the decision-making process can be efficiently communicated to the applicants and better reflected in the feedback that applicants receive. This is important for the legitimacy of the decision-making process;
- We also recommend, in order to reduce the environmental impact of the RIs, that RCN includes incentives for the development of easy remote access/control/services to the infrastructure not only to data but also, when possible, to pilot all or part of the experiments carried out.

In the Norwegian system, with the now established clear division of responsibilities for the investment portfolio at RCN and the operations at RPOs, there is a need to jointly continue to develop this system to achieve its full potential.

RCN could play the role of facilitator of change in other parts of the research system to further strengthen development and increase long-term sustainability of the national system of RI investments. The committee recommends that:

- RCN continue and further develop strategic dialogue with the RPOs on their respective roles; i.e., RCN manages the portfolio of investments in national RIs and RPOs optimises operation and the user base of the same RIs. This is important if the RI system is to take full advantage of the INFRASTRUKTUR initiative and balance remaining side effects such as the hosting advantage of the RIs. It should also ensure a long-term positive impact on Norwegian research and society.
- RIs that require regular large investments and that have system-wide effects be funded centrally and not repetitively through the INFRASTRUKTUR competitive funding scheme, to ensure continuity of its system-wide importance and to avoid difficult priorities with more specialised RIs. This is currently mostly related to UNINETT Sigma2 AS (hereafter Sigma 2).
- RCN promote an analysis and overview of incentives for operating RIs at RPOs and associated base funding to facilitate sustainable funding of operations of RIs.
- RCN, together with the RPOs, promote training of highly skilled people needed for operating RIs in the research system. We would especially mention data stewards as a new category that does not yet have a place in the system.
- RCN, in close cooperation with the RPOs, increase efforts to develop Norwegian EOSC participation and Norwegian influence in EOSC development. It will be important to have all parts of the system involved to ensure development of an efficient system adapted for research.
- RCN, together with RPOs, investigate ways to make RIs more resilient to the threat of cybersecurity, especially the growing threat of cybercrime. This could include awareness-raising sessions on this topic during Infra Days or including it as a topic in international collaborations such as ESFRI and EOSC, or perhaps promoting educational efforts.

In addition, the committee makes the following simple recommendations around FAIR data stewardship. The first recommendation is general and intended for all stakeholders of the research system, including funders of projects and RIs as well as RPOs. The second recommendation is intended for RCN in cooperation with RPOs.

- All types of research funding should require a proper data stewardship plan that includes data management during the project. The data stewardship plans must also ensure that research data be available for access and reuse where appropriate and subject to appropriate safeguards, also after completion of the project (suggested time frame: 10 years) and also cover provisions for appropriate long-term preservation. These aspects should be based on compliance with the FAIR guiding principles and include budget plans.
- RCN should develop a proper and effective policy for data stewardship so that the data generated through their investments do not go to waste and science is properly served. Such a data stewardship policy should be implemented in the applications scheme with relevant criteria for receiving RI funds. The policy should be developed in close dialogue with the RPOs to ensure that the institutions implement it together with their data strategies to create a data-responsible Norwegian research system. This policy should particularly ensure that all new undertakings include a data stewardship plan or protocols that explicitly address data capture, management, integrity, confidentiality, retention, sharing and publication.

Sammendrag

Hovedkonklusjonen i evalueringen er at Forskningsrådets nasjonale satsing på forskningsinfrastruktur (INFRASTRUKTUR) er en suksess som har stor betydning for det norske forskningssystemet. Evalueringskomiteen anbefaler på det sterkeste at ordningen videreføres som hovedmekanismen for å støtte investeringer i nasjonale og internasjonale forskningsinfrastrukturer.

Forskningsrådets INFRASTRUKTUR-ordning ble etablert i 2009 for å finansiere nasjonale og internasjonale forskningsinfrastrukturer. Ordningen var resultatet av regjeringens respons på den raskt økende betydningen av forskningsinfrastruktur, som beskrevet i stortingsmeldingen Klima for forskning fra 2009. Målet med INFRASTRUKTUR-ordningen er å sikre at norske forskningsmiljøer og næringsliv har tilgang til relevant og oppdatert infrastruktur som legger til rette for forskning av høy kvalitet for et innovativt og bærekraftig samfunn. Ordningen skal bidra til å møte kunnskapsutfordringene samfunnet står overfor.

Forskningsrådet besluttet i 2019 å evaluere INFRASTRUKTUR-ordningen for å belyse hvor godt ordningen bidrar til å nå målene som er satt, vurdere merverdien av finansiering av forskningsinfrastruktur gjennom ordningen, samt å videreutvikle ordningen. En internasjonal evalueringskomité ble etablert med mandat om å vurdere følgende områder:

Effekter av INFRASTRUKTUR-ordningen på forskning og forskningssystemet

- Samfunnsnyttene av finansierte forskningsinfrastrukturer
- Organiseringen av finansierte forskningsinfrastrukturer
- Organiseringen av INFRASTRUKTUR-ordningen

Komiteen analyserte bakgrunnsmateriale fra Forskningsrådet og intervjuet sentrale interessenter, inkludert ledere av forskningsinfrastrukturer, universitets- og instituttledelse (prorektorer og dekaner), brukere av infrastrukturer og ansatte ved Forskningsrådets avdeling for forskningsinfrastruktur. Evalueringen ble utført under covid-19-pandemien, og alle intervjuer og samtaler ble derfor gjennomført digitalt, hovedsakelig gjennom videokonferanser.

Evalueringskomiteen er fornøyd med kvaliteten på bakgrunns materialet og det gode samarbeidet med de ansatte i Forskningsrådet. Komiteen er taknemlig for at alle interessenter tok seg god tid og at de med sitt engasjement og kunnskap gjorde intervjuene til en svært nyttig erfaring.

Denne evalueringen har, som andre evalueringer, sine begrensninger. En opplagt utfordring er at det ikke finnes enkle måter å vise årsakssammenhenger mellom investeringene i forskningsinfrastruktur og effekten på forskningskvalitet og samfunn. Vi har prøvd å veie opp for disse begrensningene ved å benytte komiteens erfaringer fra forskjellige forsknings-

systemer i analysene av de ulike informasjonskildene, inkludert intervjuer og skriftlige rapporter.

Det norske systemet for å finansiere forskningsinfrastruktur er unikt. Å ha en slik finansieringsordning i ett forskningsråd, som dekker alle områder innenfor forskning og innovasjon, er sjeldent. Selve måten å finansiere og organisere forskningsinfrastruktur på er også ganske unikt i internasjonal sammenheng, særlig rollefordelingen mellom Forskningsrådet og de forskningsutøvende institusjonene (hovedsakelig universiteter og forskningsinstitutter). INFRASTRUKTUR-midlene er primært ment for strategisk viktige investeringer i nye nasjonale forskningsinfrastrukturer eller større oppgraderinger basert på forskningsmiljøers behov. Institusjonene har selv det fulle ansvaret for drift, inkludert driftskostnader, og for å gjøre dem åpent tilgjengelige for norske forskningsmiljøer.

Målet med denne evalueringen har vært å gi svar på spørsmålene "Hva er verdien av INFRASTRUKTUR-ordningen for norsk forskning og for samfunnet for øvrig?" og "Kan ordningen forbedres med hensyn til fremtidige behov til forskningen og samfunnet?".

Det korte svaret på det første spørsmålet er at allerede etter de første ti årene har den gitt norsk forskning nye eller oppgraderte forskningsinfrastrukturer av høy internasjonal standard. Dette har hatt stor betydning både for forskningen hos institusjonene og for internasjonalt forskningssamarbeid. INFRASTRUKTUR-ordningen er også et viktig virkemiddel for å oppnå mer FAIR data (Findable, Accessible, Interoperable og Reusable), som har stor betydning for mer effektiv forskning og for bruk av data i samfunnet og i næringslivet. INFRASTRUKTUR-ordningen begynner også å vise positive effekter for samfunnet gjennom flere brukere fra næringslivet, økt samhandling mellom universiteter og næringsliv og viktige fremskritt innenfor sentrale områder som klima, helse, miljøvennlig energi og sosial velferd. Effektene på de sistnevnte områdene er langsiktige og forventes å øke med tiden. Dette forutsetter at det også fremover gjøres nødvendige oppgraderinger og nyetableringer som oppfyller behovene til den banebrytende forskningen.

Relatert til det andre spørsmålet om hva som kan forbedres, viser evalueringen at INFRASTRUKTUR-ordningen er satt opp på en systematisk måte der aktørene i forskningssystemet har tydelige roller. I tillegg administreres ordningen på en utmerket måte. Forskningen er imidlertid i kontinuerlig utvikling, og vi har

identifisert noen utfordringer med ordningen og gitt anbefalinger om hvordan de bør håndteres. De viktigste anbefalingene er oppsummert nedenfor. Utfordringer og detaljerte anbefalinger beskrives i detalj i kapittel fem.

Evalueringskomiteens viktigste anbefaling er at INFRASTRUKTUR-ordningen bør videreføres som den viktigste mekanismen for investeringer i nasjonale forskningsinfrastrukturer og norske noder i internasjonale forskningsinfrastrukturer. Ordningens størrelse bør balanseres mellom behovene for investeringer i forskningsinfrastrukturer (gjennom Forskningsrådet) og institusjonenes evne til å finansiere drift av forskningsinfrastrukturene (gjennom brukere og institusjoner).

For å forbedre INFRASTRUKTUR-ordningen ytterligere, og for at Forskningsrådet skal fortsette å være en pålitelig partner i den strategiske utviklings- og beslutningsprosessen, anbefaler vi at Forskningsrådet:

- gjennomfører landskapsanalyser for å kartlegge behovene for nye investeringer og oppgraderinger av eksisterende forskningsinfrastrukturer i et 15 års perspektiv.
- videreutvikler *Norsk veikart for forskningsinfrastruktur* til å i større grad ta hensyn til internasjonale trender og utvikling innenfor forskningsinfrastrukturområdet, samt mulighetene og truslene mot norsk forskning, samfunn og næringsliv. Vi foreslår videre at veikartet i større grad brukes til å identifisere områder som trenger ytterligere støtte for å opprettholde eller utvide konkurransekapasiteten, for eksempel knyttet til grønn vekst og digitalisering.
- utvikler ulike sett med suksessindikatorer og overvåker disse regelmessig.
- sørger for at kostnadene for bruk av forskningsinfrastruktur på en systematisk måte inkluderes i søknader om FoU-prosjekter på tvers av alle budsjettformål og porteføljer som administreres av Forskningsrådet.
- vurderer hvordan kriteriene som brukes i den strategiske/ administrative delen av søknadsbehandlingen kan kommuniseres bedre til søkere og bedre gjenspeiles i tilbakemeldingene til søkerne. Dette er viktig for tilliten til tildelingsprosessen.
- stimulerer til søknader som tar sikte på å begrense miljøfotavtrykket av forskningsinfrastrukturer. Vi anbefaler også at Forskningsrådet i søknadsprosessen inkluderer en sjekk av muligheten for å utvikle en enkel fjerntilgang til infrastruktur-tjenester, ikke bare til data, men også for å pilotere (deler av) eksperimentene som er utført.

Fordi det norske systemet har en klar rolledeling med investeringer i ny og oppgradert forskningsinfrastruktur gjennom Forskningsrådet mens drift dekkes gjennom institusjonene, så er det behov for å utvikle dette systemet i fellesskap.

For ytterligere å styrke utviklingen og for å øke den langsiktige bærekraften til det nasjonale systemet for investeringer i forskningsinfrastruktur bør Forskningsrådet legge til rette for endringer også i andre deler av forskningssystemet. Komiteen anbefaler at:

- Forskningsrådet bør fortsette, og videreutvikle, den strategiske dialogen med institusjonene om deres roller, dvs. at Forskningsrådet styrer porteføljen av investeringer i nasjonale forskningsinfrastrukturer og institusjonene optimaliserer driften og brukerbasen til disse. Dette ville være viktig for å videreutvikle systemet og kunne dra full nytte av INFRASTRUKTUR-ordningen og samtidig balansere bieffekter. Dialogen bør også bidra til en fortsatt og langsiktig positiv betydning for forskning og samfunn.
- Forskningsinfrastrukturer som krever regelmessige, store investeringer og påvirker hele forskningssystemet bør finansieres sentralt og ikke gjennom konkurranseutsatte INFRASTRUKTUR-midler. Sentral finansiering vil sikre kontinuitet og begrense vanskelige prioriteringer mellom disse infrastrukturene og mer spesialiserte infrastrukturer. For øyeblikket gjelder dette særlig UNINETT Sigma2 AS.
- For å legge til rette for bærekraftig finansiering av drift av forskningsinfrastrukturer bør Forskningsrådet lage en oversikt over insentiver for slik drift ved institusjonene med tilhørende grunnfinansiering.
- Forskningsrådet, sammen med institusjonene, fremmer opplæring av kompetent personell til å betjene forskningsinfrastrukturer. Spesielt vil vi nevne "dataforvaltere", en ny stillingskategori som ennå ikke har fått en etablert plass i forskningssystemet.
- Forskningsrådet, i nært samarbeid med institusjonene, øker innsatsen for å utvikle norsk deltakelse i European Open Science Cloud (EOSC) og norsk innflytelse i utviklingen av EOSC. Det er viktig at alle deler av forskningssystemet involverer seg for å sikre utvikling av et effektivt EOSC tilpasset forskningen.
- Forskningsrådet, sammen med institusjonene, bør undersøke måter å gi infrastrukturene større IKT-sikkerhet og særlig gjøre dem mer motstandsdyktige mot nettkriminalitet. Dette kan for eksempel inkludere økt bevissthet om temaet under Forskningsrådets Infradager eller det kan inkluderes som et tema i internasjonalt samarbeid som ESFRI og EOSC.



The fourMs lab (Music, Mind, Motion, Machines) is a world-class research infrastructure for studies of music-related body motion, music performance, and music psychology. The lab is central to the activities of RITMO - Centre for Interdisciplinary Studies of Rhythm, Time and Motion, a Norwegian Centre of Excellence. Here from a concert/experiment where data from motion tracking and pupillometry is collected.



Photos: Annica Thomsson

I tillegg gir komiteen følgende enkle anbefalinger knyttet til FAIR dataforvaltning. Den første anbefalingen er generell og ment for alle interessenter i forskningssystemet, inkludert finansierer av prosjekter og forskningsinfrastrukturer, samt forskningsinstitusjonene. Den andre anbefalingen er ment for Forskningsrådet i samarbeid med institusjonene.

- Enhver finansiering av forskning bør kreve en velutviklet dataforvaltningsplan. Disse planene må sikre at forskningsdata er tilgjengelige for gjenbruk hvis hensiktsmessig, under passende beskyttelse også etter endt prosjekt (foreslått tid: ti år) og bør også dekke bestemmelser for passende langsiktig bevaring. Dette bør basere seg på overholdelse av FAIR-prinsippene og inkludere budsjettplaner.

- Forskningsrådet bør utvikle en god og effektiv policy for dataforvaltning slik at dataene som genereres gjennom investeringene deres ikke går til spille, men heller tjener fremtidig forskning. En slik policy bør implementeres med relevante kriterier i søknadsbehandlingen for tildeling av INFRASTRUKTUR-midler. Policyen bør utvikles i tett dialog med institusjonene, slik at de vil implementere den sammen med sine datastrategier for å lage et dataansvarlig norsk forskningssystem. Denne policyen bør særlig sørge for at alle nye prosjekter inkluderer en datahåndteringsplan eller protokoller som eksplisitt adresserer datafangst, ledelse, integritet, konfidensialitet, oppbevaring, deling og publisering.

1. Introduction

The National Financing Initiative for Research Infrastructure (INFRASTRUKTUR) was established as a funding instrument in 2009. Its overall objective is to ensure that the Norwegian research community as well as trade and industry have access to relevant, up-to-date research infrastructure (RI) that facilitates high-quality research for an innovative, sustainable society and that helps to address the knowledge challenges facing society.

MANDATE

The aim of this evaluation of the initiative as a funding instrument is to shed light on how well the initiative helps to achieve this objective, and to assess the added value of funding RIs through the initiative. Findings from the evaluation will primarily be used to further develop the scheme.

For this purpose, RCN formulated several issues it wished to better understand in four headings (Terms of Reference in Annex 1):

1. Impacts of the initiative on research and the research system
2. Benefit to society from RIs that are granted funding
3. Organisation of RIs that are granted funding
4. Organisation of the National Financing Initiative for Research Infrastructure

These issues will be considered in detail in chapter 4.

EVALUATION COMMITTEE

As specified in the mandate, the committee was formally appointed by RCN in April 2020. The committee consisted of:

Prof. Lars Börjesson

Chalmers University of Technology, Sweden
Chair

Dr. Paolo Budroni

TU Wien, Austria

Olivier Lefort

Director
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Prof. Riitta Majjala

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The work of the evaluation committee was supported by Leif Eriksson, PhD, Uppsala, Sweden, former senior adviser at the Swedish Research Council and NordForsk, which provided a secretarial function, organised meetings, etc. Senior Adviser Herman Farbrot at RCN acted as contact person for and provider of material to the committee. Solveig Flock, Head of Department, Odd Ivar Eriksen, Special Adviser, Kirsti Solberg Landsverk, Senior Adviser and Kristine Brekke Harrison, Adviser, presented material to the committee during meetings.

METHODOLOGY

The committee analysed material provided by RCN, either specially compiled for the evaluation (data on calls, applications, grants, questionnaires, etc. made available through RCN Teams platform) or publicly available on its website (wording of calls, strategies, white papers, evaluations, etc.). This analysis was complemented by interviews and material available on other websites such as the ESFRI website.

A summary of the initiative, referred to as the portfolio report, introduced the initiative, basic material such as Excel spreadsheets showing grants, and general information about the initiative were presented to the committee at the first meeting. Some complementary information was provided along the way. Specific questions were answered and added. The committee had a total of six video meetings with RCN representatives. RCN also provided material requested by the committee from RPOs which are hosting RIs (a questionnaire) and from the RIs (fact sheet, self-evaluation, as well as user surveys for RIs fully or partly in operation). RCN strategies for RI, Tools for Research, and the two most recent white papers to the parliament were included, i.e. Long-term plan for research and higher education 2015–2024 and Long-term plan for research and higher education 2019–2028 (LTP 2015 and LTP 2019, respectively).

Five full days were devoted to interviews, which allowed a total of 24 interviews with RIs, including users, and six interviews with representatives from RPOs, each with several grants. Interviews with RIs lasted for one hour and with organisations for 1.5 hours. For each of the interviews with RIs, two committee members were responsible for reading background material, i.e., fact sheets, self-evaluations and user surveys (if available), and for leading the interviews. The committee chair led the discussions with the organisations. A set of predetermined questions was used for interviews, with some adaptations made according to whether the interview was with an RI or an organisation. As many committee members as possible took part in the interviews, and all of them could ask questions. RIs were selected to cover different disciplines, applied and basic research, different sizes, geographic spread, host organisations and levels of maturity as well as size of consortia and international involvement. When it comes to host organisations, we selected the four largest universities and the two largest research institutes hosting several RIs. The number of participants differed from interview to interview. For RIs representation from the host organisations, RI leadership and users were asked to participate. The interview section ended with a two-hour interview with three people responsible for the INFRASTRUKTUR initiative at RCN.

Some general material available online regarding international outlooks was used especially, such as ESFRI, ERICs, and EOSC. Three evaluations made by RCN were also used to some extent: Evaluation of the Norwegian Centres of Excellence (SFF) Funding Scheme, Mid-term evaluation of eleven research schools, and Evaluation of UNINETT Sigma2.¹

A list of the material is provided in the Appendix, including self-evaluation forms and fact sheets, requests for user surveys, questionnaires to RPOs and interview guides.

LIMITATIONS

1. The material, including the interviews, used by the committee is based on RIs granted from the INFRASTRUKTUR initiative; i.e., successful cases. This is likely to contribute to a limited perspective and not give a full understanding of the total landscape. The committee has no overview of investments made by the RPOs without involvement of RCN funding.
2. The committee did not evaluate the quality of research or innovations done at individual RIs. The use of bibliometrics was not considered since it is known to have difficulties in finding relationships between publications and use of RI. It could also be difficult to understand to what degree the RI contributed to the results in each case.
3. Quantitative analysis was not performed due to limited access to KPIs and variations in user surveys.
4. The committee could not conduct any site visits or face-to-face meetings due to the Covid-19 pandemic. The work of the committee had to be based on video meetings and materials available online, most of it through the RCN Teams or Zoom platforms. This working mode also allowed less time for focused, deep-dive discussions about the material compared with traditional evaluations.

1. Evaluations can be found at RCN (link below) and specific references to other material will be made by footnotes throughout the report. <https://www.forskningsrådet.no/en/about-the-research-council/publications/?q=undefined&type=4>

2. INFRASTRUKTUR as part of the Norwegian Research and Innovation system

The 1990s saw a rapid development of scientific methods and equipment in most areas of science as well as an increasing need to pool and organise human and financial resources to run and use them effectively. The success of sequencing the human genome in 2003 would not have happened without a focus on the tools and infrastructure needed, on their development, and on financing of large-scale projects. This development of automation, digitalisation and reliance on databases was not restricted to DNA sequencing, and it soon became clear that funding systems focused on grants for research projects had problems to keep up with development.

The problem of financing large-scale facilities had also been discussed at European level. After the Convention concerning the construction and operation of a European Synchrotron Radiation Facility was signed in 1988, no more new facilities were built during the nineties. It was thought that increased collaboration and coordination among states were needed to overcome this situation, and the European Strategy Forum for RI (ESFRI) was formed in 2003. It was primarily an attempt to increase cooperation between national funding systems to enhance European competitiveness through pan-European funding of large-scale research facilities. One of the first outcomes was a pan-European roadmap for RIs in Europe in 2006. At the national level this also added to the questions of planning, prioritisation and funding of equipment and facilities, and stimulated most European countries to initiate work on national roadmaps and new funding schemes for RIs.

The development described above was also seen in Norway. During 2004 and 2005 equipment needs were estimated at NOK 2.6 billion for equipment costing less than NOK 100 million and at NOK 3.2 billion for equipment costing more than NOK 100 million for the period up to 2010 (when comparing these figures with other countries it should be noted that Norway has one research council that covers all research and innovation areas). The Norwegian Government did provide funds for investments in equipment, but they were very limited – NOK 10–20 million per year – and the mechanism for distributing them was not based on external peer-review.

RCN proposed a new funding scheme in the 2008 Tools for Research strategy. The proposal was included in the white paper on research in 2009. It built the foundation for a new funding initiative, the INFRASTRUKTUR initiative, at RCN with the first call in 2009.

The intention was threefold:

- establish a RI landscape that enabled Norway to meet challenges in areas such as health, climate and energy in a constructive, cost-effective manner.
- create a framework for effective assignment of roles and a transparent, strategic prioritisation process that safeguarded quality and ensured consistency in the procedures for awarding allocations.
- make Norwegian research groups known internationally for their ability to provide outstanding RIs.

A principal framework for roles was set early. The initiative does not fund basic equipment which several different RPOs are expected to have. The RI should be of national interest. Generation and collection of research data are not included in investments, nor can they be funded through the initiative. Handling of international collaborations are described in more detail below. Responsibility for building and operating RIs should lie with the RPOs. These could apply for investment grants, covering a maximum of the first five years of an RI's life, in the biannual calls from RCN. RCN does not primarily fund operations after this period through the INFRASTRUKTUR initiative but allows users of RI to apply for funds for using RIs in their research project applications. This could either be direct costs for use or depreciation costs for equipment. There are, however, some special conditions under which RIs can be partially supported with funds for operations. These conditions are described in the calls from the INFRASTRUKTUR initiative.²

The investment grants could be between NOK 2 million and NOK 200 million for up to five years. The funding agreement, however, covers up to 10 years to include the commitments from the recipients for operations. The RPOs themselves are supposed to invest at the lower end of the funding scale. The ministries are supposed to take over responsibility for and make decisions on investments at the upper end of the funding scale. Building RI stepwise is encouraged, however, and in these cases the total investment, consisting of several grants from RCN, could add up to more than NOK 200 million.

When it comes to strategy, the roles are complex. In principle the white papers from the government set the scene. But RCN and other organisations are advisers to the government, so it is more of a strategic conversation at the systemic level. A new white paper is expected to be published every fourth year.

² Chapter 5 in 'What type of research infrastructure is eligible for funding?' <https://www.forskingsradet.no/contentassets/694bf48daf7d43499bbc53b3a-69f9a46/200621-eligible-for-funding.pdf>

RCN published a strategy for RI – *Tools for Research* – in close connection with this scheme as input to the white papers in 2008, 2012 and 2018. At the RCN there is also a level of strategic discussion in the portfolio boards with area or thematic responsibilities. These are supposed to produce strategies for their fields of responsibility. The RPOs that apply for RI investments of course also have their strategies, which although under the same white paper umbrella could differ from RCN’s strategies. Applicants must show how their proposals fit into the research strategy of their own organisation and, if they have partners, each partner must do likewise. It should be noted that it was not until 2020 that a university – University of Oslo – presented a roadmap for RI. This is an indication of the time it takes to change the system and establish new ways of strategic thinking. We will come back to this in chapter 3.

In the application process RCN has set up to deal with these levels, the first phase considers the scientific merits of the application. Only those that rank 5 or higher on a scale from 1 to 7 will be considered in a second phase, where strategic and administrative perspectives are considered. The first evaluation is carried out by panels of experts outside RCN, i.e. international experts, and the second by panels of RCN personnel. The panels are organised according to strategic areas rather than scientific disciplines. One application can be assessed by several panels

and higher education 2019–2028, is a clear indication to applicants in the next call on how the strategic process is done.³

DEVELOPMENT 2009–2020

Between 2009 and 2020, six calls were processed and a seventh was in progress (see Table 1). The seventh call closed in November 2020 and is currently being processed. In the beginning there was most likely a high level of uncertainty about what kind of applications that might be suitable which is reflected in the big initial decrease in application numbers. From 2012 onwards the numbers have, however, slowly, and steadily increased. In the four calls between 2012 and 2018, an average of just over 70 % of the applications were assigned an overall grade of 5 or higher (on a scale from 1 to 7) by the referee panels. Thus, most of the applications made it to the second phase of the application process.

In 2014 the government introduced a 10-year perspective for budget ambitions that has since been followed up. As can be seen in Table 1, this has resulted in higher and more stable budgets for the INFRASTRUKTUR initiative, but since the needs (number of applications and amounts sought) increase with each call, the discrepancy between available funds and needs increases over time.

Calls for proposals	Number of grant applications	Amount sought (NOK million)	Number of projects awarded funding	Amount allocated (NOK million)	Percentage, allocated/ sought
2009	250	6500	22	474	8 %
2010	150	4000	18	508	13 %
2012	70	2700	16	505 (555)	19 %
2014	88	4500	31 (37)	1385 (2580)	31 %
2016	92	5700	21 (23)	1090 (1290)	18 %
2018	114	6700	20	1012	15 %
2020	121	9400	In process	In process	In process

Table 1: The first seven calls in the INFRASTRUKTUR initiative. The numbers in brackets include projects decided by the government but these are not included in the column on the right. (Source: Research Council of Norway)

if it covers several areas or somehow lies between areas. Based on the recommendation from this process, the executive board of the RCN makes the decision on which applications to fund.

The strategic component is summarised in a roadmap that is produced the year after the call. It has two parts: one is based on portfolio plans from the portfolio boards at RCN and gives an overview of needs without detailed project descriptions. The second is based on the recent call and gives more details of projects, both funded and some that were just below the budget line and was not granted funds. The latter ones are worthy of funding and are invited to compete in the next call. This document together with the latest white paper from the government, currently the Long-term plan for research

The size of the average grant has increased over time and no grants below NOK 10 million were awarded in the two most recent calls. To expand the range of available research tools as fast as possible, priority has been given to spreading the funding over many projects rather than concentrate it on a few. The size of the grant is determined in negotiations starting from alternatives given in the applications (for grants over NOK 30 million). In most cases the size of the grant is less than the highest amount applied for.

3. The latest roadmap 2020: <https://www.forskningsradet.no/en/apply-for-funding/funding-from-the-research-council/infrastruktur/veikart-for-forskningsinfrastruktur/>

The Government’s Long-term plan for research and higher education 2019–2028: <https://www.regjeringen.no/en/dokumenter/meld.-st.-4-20182019/id2614131/>

	low	average	high
2009	2.4	21.5	80
2010	2	27.8	80
2012	4.5	31.6	53.9
2014	7.8	44.7	133.6 (419.9)
2016	10.9	51.9	143.1 (200)
2018	12.6	50.6	100

Table 2: Size of grants in the INFRASTRUKTUR initiative. The numbers in brackets refer to government decisions. (Source: Research Council of Norway)

The application process has essentially stayed the same over time. One change was made in 2018 to promote more coordination and collaboration nationally. A first step, requiring submission of a project outline six months before the deadline for the final round of applications, was made mandatory to be eligible to apply for funding in the final application round. All applicants received an overview of the titles, summaries, partners and contact persons for all outlines submitted. The idea is to identify potential missed opportunities for national collaboration. The outlines have also helped RCN get started on the process of finding reviewers a little earlier.

However, the outline is not used in the final application round. Nor does RCN take an active role in coordinating initiatives to enhance collaboration between applicants with potentially overlapping or closely related ideas. Still, the number of outlines was higher than the number of final applications in both 2018 and 2020 (165/114 in 2018 and 166/121 in 2020).

The latest call can be found on the website⁴ and gives a lot of detailed information about the process. The criteria to be used for the different types of panels are described as follows: Assessment criteria for the referee panels: excellence, impact, implementation and overall assessment by the referee/panel. Criteria for the strategic administrative panels: special requirements stipulated in the call, national importance, cooperation and distribution of tasks and responsibility, RPO strategy clarification, benefit to society, implementation and organisation and overall assessment by the administrative panel.

THE INFRASTRUKTUR INITIATIVE AND INTERNATIONAL COLLABORATION

One aspect of strategy in the RI field is internationalisation, and Norway actively participates in European forums for strategic discussions, often linked to existing RIs and ESFRI but also to new initiatives such as European Open Science Cloud (EOSC). This participation is shared between RCN and the Ministry of Education and Research, with RCN playing a central role.

Decisions regarding membership in international collaborations at the state level is the responsibility of the government, with RCN as adviser. Investments in Norwegian nodes of international collaboration, however, are treated like all other RIs; i.e., a national interest requiring applications to the INFRASTRUKTUR initiative.

In parallel with the biannual calls from the INFRASTRUKTUR initiative, there is an open-ended call for support for pre-projects (NOK 250,000–500,000) for Norwegian participation in the planning of RI on the ESFRI roadmap. This support is supposed to result in a high-quality application necessary for RCN to advise the relevant ministry on whether or not Norway should become a member. The ministry formally applies for Norway to become a member of the international RI. RCN considers the membership fee as part of the node's operating costs but could grant some support for operations during the establishment phase, usually for no longer than five years. The participating Norwegian RPOs normally must pay the membership themselves after the first five years. RCN often participates in the governing bodies of international RIs to begin with but can, after consultation with the Ministry of Education and Research or other relevant ministry, choose to appoint a resource person from a Norwegian research RPO to take RCN's place in the governing body. Discontinuation of a membership is expected to be the initiative of the responsible RPO but needs the involvement of both RCN and the government since it is a national membership.

For CESSDA ERIC, European Spallation Source ERIC and SIOS Knowledge Centre in which Norway has made binding commitments by the Government (Norway is host for the two ERICs), allocation of funds has been made outside the ordinary financial framework for INFRASTRUKTUR calls for proposals. However, to ensure that Norwegian participation in international RIs maintains the same high standard as the establishment of other national RIs, the projects should generally apply in an "ordinary way" to an INFRASTRUKTUR call for proposals. Norway has passed a special ERIC law in the parliament in 2015 to make it possible to host ERICs. The total commitments for Norway's participation in ESFRI-infrastructure are so far about 2,1 billion NOK.

4. <https://www.forskningsradet.no/en/call-for-proposals/2020/funding-research-in-frastructure/>

THE PORTFOLIO IN 2020

The portfolio of projects granted funding from RCN in 2020 consists of 136 projects with a total investment amounting to NOK 6.4 billion. The projects are spread over many areas, types of RIs, types of host RPOs and sizes of grants. The portfolio report presents a list of all the grants together with brief descriptions that underline the diversity of projects.

There are more than 30 different host RPOs. More than half of these have one or two grants. Four RPOs have more than 10 grants, three of them universities and one a research institute. Most of the grants are single grants ranging from NOK 2 million to just under NOK 150 million. According to the original intention, it should also be possible to build RI stepwise, and there are several examples of this, but only three where this led to a total investment of over NOK 200 million. Those cases have three grants. Analysis of the contracts show that just under half of the total cost for the RIs is covered by the INFRASTRUKTUR grant. RPO's own funds are the other big source of funding, while private funding accounts for around 3 %.

Several projects are collaborations between RPOs, but the contracts are signed by only one partner, the one responsible for reporting to RCN. In the following account the term 'host RPO' means contracting partner, even if there are several partners in a collaboration potentially hosting part or parts of an RI.

The background material, the self-evaluations, and the user surveys especially, reflect the diversity of RIs and host RPOs and are difficult to analyse without knowing the context for each RI when it comes to the research community, host RPO and their possible collaboration partners. Examples in the report are selected to illuminate certain aspects without necessarily representing a majority view.

Categorisation of grants is done relative to the area strategies in the roadmap, which also reflects the panels in the application review process. This makes comparisons with other countries difficult, as well as analysis of the balance between basic and applied research. It should be noted that even if a grant is categorised in a certain category, the application could have been reviewed by other panels and regarded relevant to some degree for other categories as well. Several RIs are of this kind and could also be used for both basic and applied research, and it might be more relevant to follow actual use than to estimate use from the application. The committee will return to this issue in chapter 5. The focus areas in the 2008 strategy, i.e., health, climate (included in environment below) and energy, have received almost half of the funding during the 10-year period.

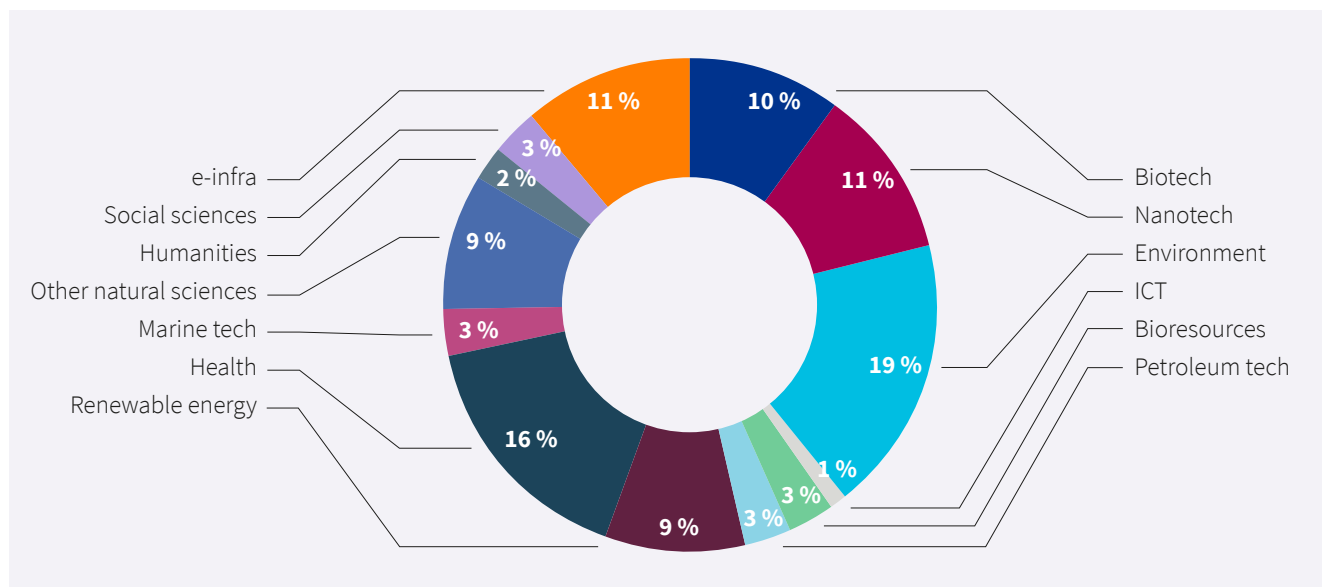


Figure 1: The distribution of funded RIs, i.e., the portfolio, by INFRASTRUKTUR 2009–2018 for the different area strategies in the Norwegian Roadmap for RIs. For ICT only the proportion invested in the establishment of RIs related to basic ICT research is shown, not investment in ICT used for the other areas. (Source: Research Council of Norway).

3. General observations

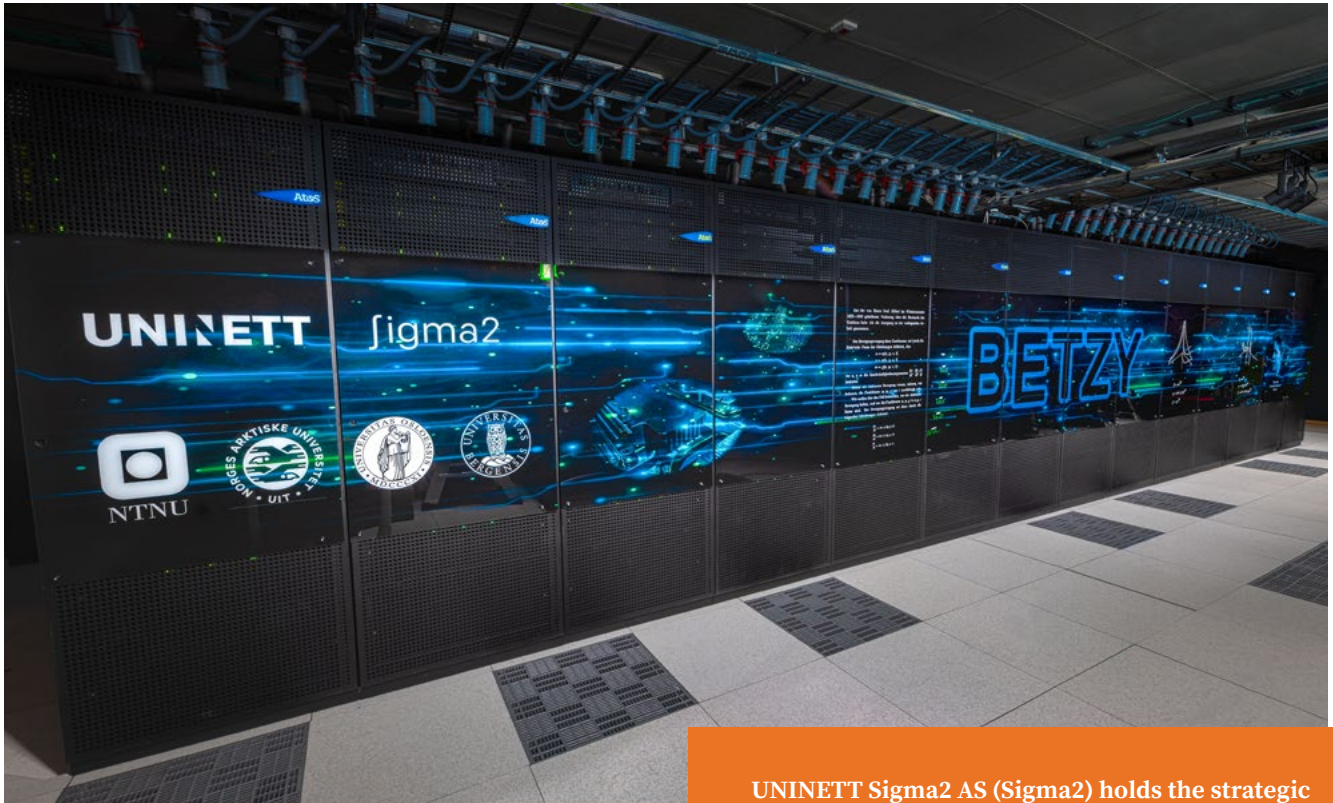


Photo: Espen Ali Johansen

This evaluation took place amid the Covid-19 pandemic, and societies are still struggling to manage the situation. However, some important aspects worth noting have already come to light, such as how research systems in general contributed to handling the pandemic, and the importance and integrated role of RIs in the research and innovation system. First, several vaccines were developed in less than a year. This is an unprecedented achievement in research. Behind it lies long-term development of tools for research both small and large, spanning from the use of enzymes to sequence nucleic acids to synchrotrons to analyse protein structures. The possibility to interpret the new virus genome into protein structures that could give rise to an immune response and help us prevent infections from the same virus, is the result of many researchers' efforts over a long time.

This could not have happened without the traditions of openness and a readiness to share data. Researchers have also worked across disciplinary borders. Funders have specifically funded both tools and the development of tools. Most important is the breadth of research that has been supported. While waiting for vaccines to help us fight the pandemic, we struggle to stop the virus spreading in our societies. This is to a large extent a question of understanding human behaviour and the structure of the societies we have built. It

UNINETT Sigma2 AS (Sigma2) holds the strategic responsibility for and manages the national e-infrastructure for large-scale data- and computational science in Norway. This is Betzy, the most powerful Norwegian computer of all time, named after Elizabeth (Betzy) Stephansen, the first Norwegian woman with a doctorate degree in mathematics. Betzy is one of several supercomputers in Sigma2's service.

could be asked whether we supported research in areas such as the humanities and social sciences enough in the past to be prepared for this challenge.

We see that Norwegian research was well prepared when the pandemic arrived, thanks not least to support from the INFRASTRUKTUR initiative for projects that are now helping to identify virus variants, understand differences in proteins in these variants, and to develop new tests. Several of the grants in the portfolio helped lay the groundwork, and this should be recognised. Starting with the Norwegian examples just mentioned, we believe there is now a window of opportunity to showcase the role research plays in modern society and how modern research is performed, and its reliance on a variety of highly skilled people with access to advanced tools and commonly

accessible data. This idea will be developed in chapter 5, but we would already here like to stress our belief that there is a need for a new type of forum for discussion between RCN and the RPOs. After showcasing what has been achieved in relation to the pandemic and then moving on to other areas, such as environment and climate, the next step would be to discuss what to achieve in the future.

Apart from showcasing RIs and related research, we see a need for discussions in the proposed forum on what RIs are and how to make best use of them in the Norwegian system. There have been several recent reports that can serve as a point of departure for these discussions, and we cite ESFRI.⁵ 'RIs must be viewed not as stand-alone installations, but as part of the broader system contributing to the longer-term development of research and innovation. This system is not only capable of integrating RIs in and across scientific domains but must increasingly create knowledge and innovation hubs around state-of-the-art RIs, attracting high-level expertise and creativity and providing space for sharing knowledge and ideas.'

During its first 10 years the INFRASTRUKTUR initiative has started a transformation of the Norwegian research system that needs to be sustained and strengthened. The Norwegian research funding system has established a unique model for investing in and operating RIs, but it is still nascent. We suggest that RCN use the OECD report *Optimising the operation and use of national research infrastructures*⁶ as a starting point for discussions with the RPOs. Since many of the RIs have only recently or are just about to start their operations, they have a lot to gain from guiding models on how to develop and optimise user bases in order to stabilise operations funding.

The forum proposed above serves to build trust among actors in the research system but also among the public. Therefore, it should be remembered that while the reference to vaccines as a success story for research is true, there are vaccine candidates that did not meet expectations, and these are also part of research. Ideas must be tested, and some will eventually fail but still be part of the total knowledge creation. In a world with media looking for failures that can be turned into scandals, usually by framing them as a waste of taxpayers' money, researchers and their organisations must explain and defend their methods. Being able to show good effects in less than a year is extremely unusual; more often it takes many years, large investments, and several failures. The forum needs to take this into account in its discussions. During this evaluation, a lack of discussion about the environmental effects of RIs themselves was noticed. RIs do not have a green card, and their environ-

mental effects must be known and dealt with. Among the possible effects, the increasing need for the computation and storage of data from ever more capable data-producing sensors could have a negative environmental effect through the need for energy resources, and this has to be taken into account.

Setting up the forum is not a simple question of inviting RPOs; it needs to be framed so that discussion can be at a level where RIs are part of the research system rather than stand-alone investments (see citation from ESFRI above). We think there is a need for broader participation from RCN than the INFRASTRUKTUR initiative in this connection, although the initiative should facilitate the discussions as organiser, and all host organisations need to participate or organise themselves in clusters to make meetings more effective. An alternative would be to focus on the RPOs with the most grants in a first phase. We note that FAIR and EOSC will transform many areas of research, but during our interviews we could not get a clear picture of how the RPOs or the RIs will approach this transformation. A focus on fewer RPOs with many RI projects might be a way to speed up the transformation and develop a Norwegian way of handling this transformation.

Experience from other countries show that it is not enough to just assemble representatives for a meeting. These people need to have a clear mandate and a channel for reporting back home. To save time, this should be the norm from the start in a Norwegian setting. The discussions should not be restricted to the INFRASTRUKTUR initiative and the application process. There is obviously a need for discussions involving both investments in and operation of RIs as well as strategic development of the whole system.

In the following we will make more detailed comments about findings and recommendations in relation to the INFRASTRUKTUR initiative and to the Norwegian research system. It is our hope that these can help develop the INFRASTRUKTUR initiative and/or serve as starting points for discussions in the forum described above and lead to rapidly accepted changes which in turn will enhance Norwegian competitiveness in an international setting.

5. ESFRI white Paper 2020, 'Making Science Happen' (page 15): https://www.esfri.eu/sites/default/files/White_paper_ESFRI-final.pdf

6. https://www.oecd-ilibrary.org/science-and-technology/optimising-the-operation-and-use-of-national-research-infrastructures_7cc876f7-en;jsessionid=JUxhw-fzmbBLLDdeF6FhUAPZp.jp-10-240-5-184

4. Findings

4.1 IMPACTS OF THE INITIATIVE ON RESEARCH AND THE RESEARCH SYSTEM

4.1.1 General comments

RCN has worked out a highly systematic approach to fulfilling the Government's plan to increase investment in RI, or *Tools for Research*, for increased impact of and quality in the Norwegian R&I system. The initiative has provided substantial new funding for investment in RI in Norway and for international collaboration. RCN's approach includes several measures to ensure effectiveness and high quality in the investments as well as fulfilling the most important needs of the research community, such as road mapping of the needs of RIs, a framework for open national/international access to RIs, and priority procedures of applications using both international expert peer reviews and assessments with regard to relevance for Norwegian strategic priorities. This has been complemented with communication efforts directed at the Government and at the researchers and RI host organisations to increase understanding of the approach taken.

The Norwegian research system is rather unique in several ways; for example, having one research council covering all areas of R&I is rare. Another approach, which is also relatively unique in the international context, is that INFRASTRUKTUR funds are primarily intended for investments in new national RIs or larger upgrades, whereas the RPOs have full responsibility for the operations, including the operating costs. Thus, there is an important division of roles between RCN, which funds investments in RI of high national priority, and the RPOs, which have responsibility for operating these RIs (including operational funding). These differences will have to be considered when comparing with other countries.

After 10 years, the INFRASTRUKTUR initiative has become an indispensable part of the Norwegian funding landscape.

It is among RNC's largest budget items, and its importance has been made clear in both questionnaires and interviews. The following three texts are taken from questionnaires, and the first contains almost every possible variation on the same theme: 'Large National RIs (RIs) are absolutely crucial for supporting high quality world-class research (and often innovation) in many disciplines. They are an essential enabler of science, but it is also one of the most strategic tools for being an attractive research and innovation partner internationally. The INFRASTRUKTUR scheme is paramount for providing investment support that most research RPOs cannot afford by themselves.' The increase of the budget in 2014 has also been noted: 'We are strongly supportive of the increase in available funding for RI in recent years, due to its impact on scientific quality and the attractiveness to partners and employees.' RCN also gets positive feedback: 'We want to use this opportunity to express our appreciation of the competent and efficient people at the RCN working in connection with the INFRASTRUKTUR initiative.'

However, RIs are, by their very nature, long-term investments, and 10 years is usually only the beginning. It is therefore also interesting to look at the overall development of the research system to understand the landscape where operations should be funded as well. The Norwegian research system has seen a total increase in spending, especially in the higher education institutions (HEI) sector after 2014, while the research institute sector has stayed at the same level (note that Figure 2 is shown in fixed 2015 prices).

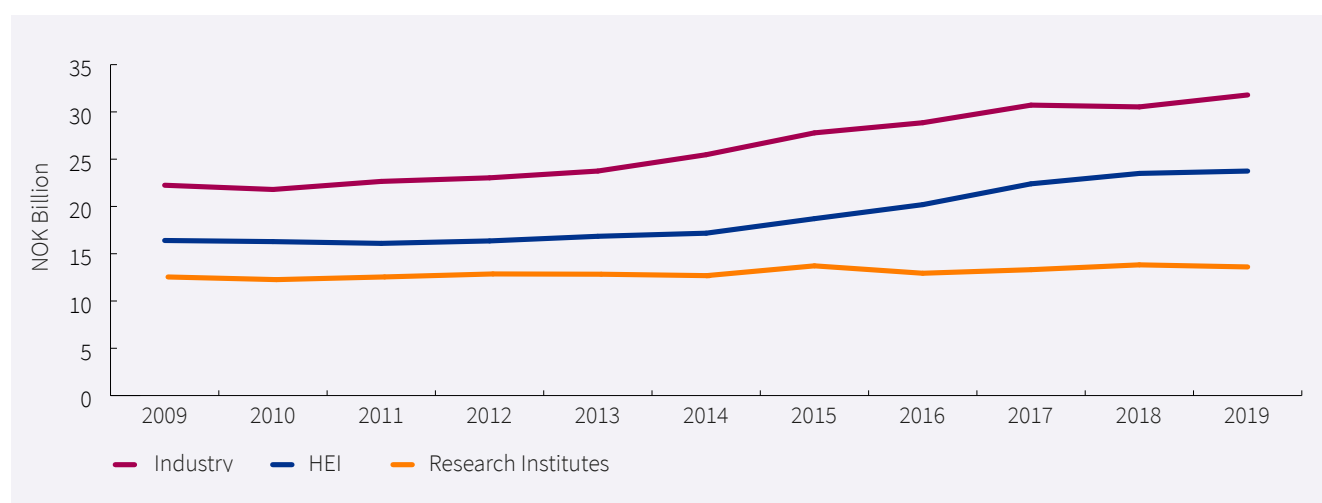


Figure 2: Total R&D expenditure in Norway 2009–2019 by sector (HEI: higher education institutions; data downloaded in April 2021 from NIFU's website⁷, fixed 2015 prices).

7. <https://www.nifu.no/fou-statistiske/fou-statistikk/hovedtall-3/>

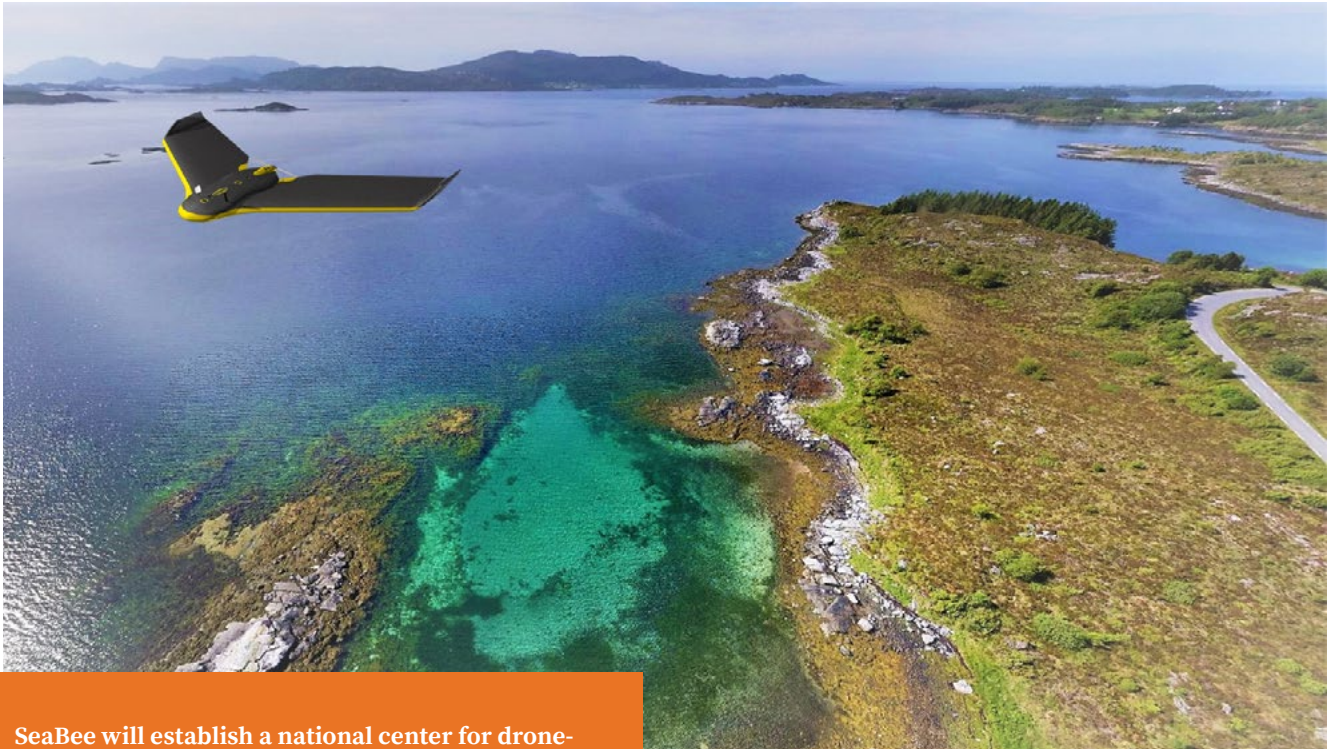


Image: Kaper Hancke/SeaBee/NIVA

SeaBee will establish a national center for drone-based services for use in coastal and aquatic research, mapping and monitoring of habitats, animal communities, and anthropogenic impacts. In this illustration a fixed-wing drone is at work at 85m altitude on the Norwegian west coast, mapping and identifying marine algae, vegetation and litter/plastic in the coastal zone.

However, the explanatory text to this figure is worrying: 'Salaries comprise more than 60 % of the spending on R&D. Compared to 2018 the preliminary figures for 2019 show that spending on salaries increased more than the total spending, while spending on buildings and scientific equipment (capital expenditures) decreased. This is mainly due to the significantly lower expenditure on buildings in the institute sector in 2019.' (*translated from Norwegian*).

These trends must be followed closely, but they underline how important the INFRASTRUKTUR initiative has become in the funding system after only 10 years, and changes to the initiative must be viewed and effects analysed in this broader context. Even if the HEI sector has had the best development since 2014, one of the big universities reported that it was heavily dependent on the INFRASTRUKTUR initiative to establish and participate in large national and international research facilities.

There is no doubt that the INFRASTRUKTUR initiative, and the way it has been set up, has had significant effects on the availability of some of the most advanced research tools and thereby on the quality of research in the Norwegian system. It has simultaneously had a significant structuring effect on the system

in that the RPOs are encouraged to make strategic planning of the investments align with both their internal and national research agendas while satisfying the requirement of making common national RIs open to national and sometimes international researchers.

It has been more difficult, however, to go into detail. In the material presented and the interviews it has not been possible to identify a common set of performance indicators. Although some seem to be aware of the work done by an ESFRI working group⁸, there is more work to be done in this respect. The need for common performance indicators is also something that has become more evident during the time the INFRASTRUKTUR initiative has been in operation. Norway had a national expert participating in the ESFRI WG group, so the result is known at RCN.

One particularly important aspect of impact is that the INFRASTRUKTUR initiative has set a standard for expectations of what can be achieved in the Norwegian research system. Compared to the situation before 2009, where it was almost impossible to fund RI or even equipment, there is now a clear way and a possibility to compete using the best RI and equipment. This is extremely important for a country to retain or attract the best researchers in its research system and to recruit internationally.

The INFRASTRUKTUR initiative has thus successfully fulfilled the important task given to RCN in 2009 to increase investments in

8. https://www.esfri.eu/sites/default/files/ESFRI_WG_Monitoring_Report.pdf

national RIs at RPOs. The need was identified as a structural gap in a governmental white paper for increasing quality in Norwegian research and higher education. It has had a significant impact on the development of strong research environments and has raised interest in Norwegian research within the country as well as abroad.

SPECIFIC QUESTIONS IN TOR

4.1.2 What role has the initiative played in meeting the research community's needs for RIs and services (both internal and external users)?

Compared with the situation when the initiative started in 2009, it has been instrumental in increasing investments in RIs for Norway. Table 1 shows a total sum of more than NOK 6,4 billion for investments in RI since the start of the initiative. This has a huge effect and is a real game changer for Norway being able to establish and develop new and upgraded RIs of high international standard.

This effect was also clearly recognised during the interviews and when the representatives talked about their RIs, many said it would not have happened without the INFRASTRUKTUR initiative, and that universities and research institutes could not have done this by themselves.

It is also clear from Table 1 that the possibility to start thinking strategically about which RIs that would benefit different research areas have been beneficial for the whole research system. There has been an increase in the number of applications and the size of the amounts sought in recent calls. When 70 % of the applications are rated 5 or higher by the scientific panel, they must be taken seriously as carefully thought-through proposals to increase research quality through RIs.

The initiative has led to more structured collaboration among the RPOs in Norway to set up advanced RIs to meet a common need for competitive research and less duplication of equipment (sometimes of subcritical performance), providing greater efficiency in the system and more advanced tools for higher research quality. Thus, the INFRASTRUKTUR initiative has been instrumental in elevating discussions on priorities regarding advanced equipment and RIs from the local level to a more general and national level, which drives quality and satisfies the needs of the research community at large.

The structure and approach of the INFRASTRUKTUR initiative generally promote the RIs that satisfy needs in the prioritised research areas of the research communities at the RPOs, i.e., where the research communities are active, as well as in the national strategic research areas, which are supported by national funding. In this way the initiative ensures that RI funding is mostly directed towards the most active and prioritised research areas, which should also make it possible to support the operating costs through a substantial user base.

Several existing RIs have received significant new funding that has substantially boosted their national and international roles,

their quality, and their importance for the research community. This underlines the importance of the INFRASTRUKTUR initiative for satisfying the needs of the research communities.

Based on the material provided and the interviews, the RIs have generally had larger effects on research conducted at the host RPO than at external RPOs, which indicates a hosting advantage on the research impact. This is likely due to a number of reasons; the host RPO is likely the leading one because of community size or strategic research importance for the RPO, the proximity effect if the RI requires traveling, etc., but sometimes because cost models may favour host researchers who take advantage of host block institutional funding of operations. Many of the RIs could develop their national role further to ensure that they also support the needs of users from other RPOs.

For those research communities that first realized the possibilities with the INFRASTRUKTUR initiative there are now more advanced tools available for high quality research. However, it is still early days for many of the RIs when it comes to user organisation. This can be seen in the varied quality of user surveys. There are several reasons for this. One is a lack of a common definition of user, another is the difference between the projects that are funded and the type of RI that will be the result. Few RIs are organised as international ones where users apply for and gain access (often for a limited time slot) based on the scientific merit of the proposal. Many RIs have grown out of successful local initiatives that have formed the bases for applying to become a national initiative. There seems to be a need for experience sharing to get a better understanding of user organisation from the start.

4.1.3 To what extent and why is there use of / investment in other RIs when relevant infrastructures already exist under the initiative?

The first part of the question is difficult to quantify due to limited documentation available on the use of, or investments in, RIs not funded through the INFRASTRUKTUR initiative. In this evaluation, we did not look at potential overlaps between RIs financed through the INFRASTRUKTUR initiative and possible RIs financed directly from the sectoral ministries such as the Ministry of Health and Care Services. To some extent, we looked at the interfaces between related parts of the national policy instruments (*virkemiddelapparatet*) for R&D and innovation.

There are good reasons to assume that some overlap exists. Due to the sums involved and what has been said about the importance of the INFRASTRUKTUR initiative, it is unlikely that whole RIs are duplicated. Some RPOs give arguments for duplication: 'In some cases, however, advanced (and expensive) equipment is of a generic nature, supporting various prioritised research areas. When access to such equipment cannot be provided, or is not practical, over a geographical distance; or when the capacity of existing equipment is not adequate, it may be necessary to duplicate.' Timing is mentioned by another RPO, since INFRASTRUKTUR has biannual calls with less than 20 % success rates. This leaves the RPO with a difficult strategic ques-



Photo: Samuel Poudroux

Ullrigg is the world's most advanced full-scale drilling test site including an offshore-style drilling rig. The RI situated in the Norwegian "oil capital" Stavanger contributes to digitizing and automating the oil and gas sector leading to safer and more efficient energy production.

tion: invest now (if possible) to keep the competitive advantage or apply to RCN with uncertain outcome in terms of time and amount of funding. This is a difficult question for organisations competing for EU funding and could lead to unintentional duplication of whole or parts of RIs.

From the user perspective it seems to be a question of cost and use of scarce funding. Due to the limitations of the user surveys, few examples are available. There is one example of a researcher who used commercial DNA sequencing services because it was more cost-effective for the type of samples in the project. This may not apply to all sample types, and it could be questioned whether it would still apply during the pandemic and the increased demand for sequencing of virus variants. Some researchers say that their networks and collaborations give them access to more cost-effective solutions in other countries.

4.1.4 To what extent do RIs that are granted funding help raise the scientific quality of Norwegian research (enhanced competitiveness for users in calls for proposals, examples of ground-breaking research, etc.)?

In most areas modern research is dependent on digital instruments and associated databases, which is exactly what has

been funded through the INFRASTRUKTUR initiative. There are numerous examples in the background material of how this has helped raise scientific quality, including research articles in high-impact journals, new collaborations (including international ones), international recruitments, new types of grants through collaborations, more competitive advantage when competing for EU funding, including ERC grants, etc. For example, Norwegian RPOs participate in 66 projects in the H2020 RI programme, with total funding of EUR 34 million. The Norwegian proposals have a high success rate (47 % compared with the average 36 %). When interviewing, we noticed a degree of internationalisation which is particularly good for training as well. Many industries today are acting globally, and people trained in such environments are sought after. It should also be mentioned that when the evaluation of Centres of Excellence in Norway discussed the characteristics of the top centres, access to RIs was one of them. The most prominent of these is the neuroscience community in Trondheim, which has received funding for both centres of excellence and RI projects. The RI project NORBRAIN has received funding for three stages of the project totalling NOK 213 million from the INFRASTRUKTUR initiative. In its self-evaluation it states: 'From 2011, NORBRAIN has changed the scene. The project has been immensely successful, attracting more than 400 internal and external users in 100 research projects and resulting in almost a dozen articles in basic neuroscience in the journals Nature, Science and Cell since its inception in 2012, as well as the Nobel Prize in Physiology or Medicine.' RIs are also mentioned as important for research schools in the mid-term evaluation of eleven Norwegian research schools in 2018. This area could be further developed, since research schools are also excellent ways to build user communities around RIs.

4.1.5 To what extent and how does the initiative help structure Norwegian research and influence what priority institutions give to infrastructure?

The INFRASTRUKTUR initiative has had various structuring effects on Norwegian research. These effects have very positive for the whole Norwegian research system, improve research quality through more advanced and relevant RIs that are well adapted to the needs of most research communities, increase the effectiveness of investments, avoid duplicates, increase synergies between communities, increase cooperation within

and between institutions and enhance its attractiveness for international cooperation. Analysis of the background material has shown that individual RIs will show these effects to varying degrees, pending on the diversity of the RIs funded.

Increasing investments in research communities

In addition to the direct effects on research quality, substantially increasing investments in advanced national RIs has promoted cooperation between research groups in research communities at the national level to establish RIs based on common interest and needs for advancing the research. There are several examples from the health area, and Biobank Norway is one of the first and also one of the biggest total investments from the INFRA-STRUKTUR initiative.

Reforming the RI system

RCN has substantially reformed the RI system in Norway and its development by establishing systematic national quality assessment and prioritisation processes for RI needs in Norwegian research and society. Since investing in RI is a long-term decision, these aspects are very valuable to Norwegian science and society. One important aspect is the involvement of the portfolio boards at RCN in the process and the established communication channels with RPOs and RIs, such as the INFRA Day and other means.

Structuring effects on the institutions

The INFRASTRUKTUR initiative provides incentives and a framework for strategic planning at RPOs in relation to both their own research priorities and national research strategies. It has supported the development of long-term thinking and has had a clear structuring effect on development of strategic planning and prioritisation of RIs at most RPOs. This is both a bottom-up and a top-down approach, and many host institutions report that internal cooperation has improved due to this systematic approach. The structuring activities are still ongoing, and different RPOs have tackled this in different ways and are also in different phases. The strategic planning activities include processes for priority setting, synergies across faculty and department borders that enhance use, skills development, and stimulation of long-term strategies. During the interviews with host RPOs we heard about this ongoing process with the University of Oslo as an example, where the process has now resulted in a roadmap for the whole university.

Structuring effects on cooperation between institutions

The initiative has provided mechanisms for establishing shared RIs for national use in the Norwegian system and has led to enhanced cooperation and synergies between the institutions for pooling resources to make advanced tools for research nationally available to researchers and also to reduce duplication of sometimes subcritical RIs. It is evident from the interviews and background material that discussions on the needs of RIs normally start at local level within research groups and departments and are then elevated to faculty and university level before ultimately stimulating structured cooperation between institutions to establish and operate RI with support from

RCN. Sometimes this also leads to specialisation by different partners in the cooperation. The Norwegian Sequencing Centre is an example of this, with its distributed organisation, specialisation and expansion over time to include a new node.

One of the RPOs, however, underlines that more can be done: 'The funding from RCN is not sufficient to cover both reinvestment in existing national infrastructure and establishment of many new national facilities. There is thus a need for a stronger coordination between the large RPOs in Norway when applying for funding for national RI. There is, however, a lack of a national forum to discuss how to build new consortia or review old ones. The establishment and operation of such a national forum should be carried out in collaboration with RCN.'

Skills development and RI leadership

The initiative has also supported the consolidation of knowledge on managing and operating RIs throughout the country, although the skills are not evenly distributed and should be further developed. There were other 'collateral effects', not primarily intended or foreseen at the beginning, such as: skills development, awareness about the FAIR principles, data management-related issues, enhancement of processes related to quality management and assurance, reflections about sustainable development of RIs, and a development of industrial cooperation. During the interviews, the INFRA Day was mentioned as an important arena for networking and exchanging experiences. The INFRA team at RCN has also been mentioned as helpful in this respect.

Raising the level of RI to internationally competitive standards

The INFRASTRUKTUR mechanism appears to be well suited to structuring substantial investment in existing RIs to raise them to a high international standard which RPOs cannot assume alone. Thus, it fills an important structural gap. SINTEF Ocean, for example, clearly indicates that the modernisation of tools could not have taken place or would have taken place very slowly without INFRASTRUKTUR.

However, other effects were mentioned during interviews with RPOs that were not necessarily positive and that one should be aware of, such as:

Hosting advantage effects

Although the initiative clearly stimulates cooperation between institutions to jointly establish, develop and operate RI to support research agendas, there are still clear elements of competition to host RIs. It is often regarded as more beneficial to host a RI than to be a consortium member, since it often stimulates advanced use at the host institution and strengthens the institution in areas supported by the RI. The depth of knowledge that comes with daily use and exposure to all users' problems is part of this advantage and is difficult to distribute differently other than to provide the best possible service to all users. When forming contracts, RCN might need to check that the cooperation agreement addresses this issue. One problem mentioned in this connection is that if the level of funding is much lower than the amount

applied for, there might be problems over how to prepare a new budget. User service might not be given highest priority.

Centre of gravity effects

There are centre of gravity effects on the hosting of RIs. Larger and more geographically central institutions are regarded as more attractive and more experienced hosts of RIs. The centre of gravity structuring effects have pros and cons. It becomes essential that the RIs take on a true national role and break down barriers to use by researchers from other institutions.

4.1.6 To what extent does the initiative help strengthen national and international cooperation?

The initiative has strengthened national and international cooperation in several ways. Having the RIs that Norway has today increases its reputation as an attractive country for doing research and finding cooperation partners and as a partner for strategic discussions in research. The establishment of advanced RIs requires cooperation on identifying and setting priorities for the needs of the respective research communities, host RPOs and partners as well as on sharing skills and other resources. Once established, the RI stimulates cooperation through sharing best practices of use, method development and data analysis, and often become attractive meeting points for different disciplines that stimulate new interdisciplinary collaborations. The Norwegian Sequencing Centre is one such example, but as already pointed out, different RIs shows this effect to varying degrees depending on the type of RI.

National:

- Cooperation within research communities or sectors. The initiative has created the opportunity to cooperate on advanced RIs that are required for internationally competitive research and that would not be possible to establish otherwise. This increases cooperation between research groups at different locations and RPOs.
- Cooperation between different types of RPOs through partnering as hosts.
- National industrial cooperation between RPOs and industrial partners; see also section 4.2.

International:

- Through the INFRASTRUKTUR initiative, collaboration with Norwegian partners has become increasingly attractive in several ways:
- Direct use of attractive Norwegian RIs in several disciplines, which in turn stimulate the development of international collaborative research projects.
- Norwegian research groups have become more attractive for playing important roles in international collaborative research projects, since they have access to more advanced research methods at the RIs.

- The quality of the research of many Norwegian research groups has increased their impact as a result of access to the advanced RI, making them more attractive for research collaborations.

The INFRASTRUKTUR initiative has also provided substantial support to and had a strong impact on Norwegian membership and participation in international RIs through national nodes of distributed RIs, e.g., ESFRI RIs, and in some cases even European/international leadership (ECCSEL, CESSDA and SIOS). RCN has played an important and proactive role in establishing Norwegian nodes of ESFRI RIs and even in hosting ESFRI projects. RCN has then represented Norway in the development of the governance of these European RIs. This has been essential, since the ESFRI process for establishing new RIs is relatively complex and prolonged due to the need to negotiate multilateral governmental agreements and establish legal structures. Thus, INFRASTRUKTUR has been an important tool not only for the funding support it provides but also RCN support for providing an established, systematic and predictable process for Norwegian membership in ESFRI RIs.

For the ESFRI RIs where Norway is the host country, i.e. ECCSEL and CESSDA, RCN has been instrumental in their establishment through its strategic and long-term close involvement and has appeared as the guarantor of the country's commitments. This has obviously been invaluable for establishing Norwegian leadership for these RIs, which would likely not have happened otherwise. The INFRASTRUKTUR initiative has provided partial financial support for the Norwegian national node of ECCSEL and CESSDA, whereas Ministry of Education and Research supports the central hosting part of the RI.

It seems that RCN now partly leaves the governances of several European RIs where Norway is a member in the hands of the Norwegian institutions operating the national nodes, which feel they have less experience in and influence on European decision making in the governance structures. This worries several of the Norwegian institutions that host the Norwegian nodes for several reasons. They risk losing power in the European RI since they are only the operating entity and are not experienced in representing countries at the governance level in European cooperation. They are also concerned by the requirement of long-term guaranteed commitments (personnel, operating and investment budgets) to their European RI and the possibly large mismatch of the time schedule of the INFRASTRUKTUR call for RI projects, whose results are not guaranteed, with the investment plans of the European RI they are connected to. This challenge will be further discussed in chapter 5.

INFRASTRUKTUR funding has also enabled development of strong Norwegian home labs that act as gateways and support centres for Norwegian research for using larger, centralised European RIs (e.g. ESRF, CERN and ESS Neutron). These play important roles as hubs between the RI and national academia and industry, preparing the researchers for use of the international RI, competence building, support for new users as well

Modern laboratories and numerical models are necessary to describe and understand the relationship between the composition and structure of materials with their properties and how this relationship is affected by processing parameters. The structure and chemistry of surfaces affect the functionality of modern materials, components and devices in various applications. The NICE laboratory provides state of the art surface analysis services for applied industrial and basic research.



Photo: Werner Juvik (left) and Geir Mogen (right).

as facilitating Norwegian influence in the development of the large facilities. The RECX national platform at the University of Oslo and NTNU is an example of this.

By providing support to Norwegian nodes and home labs related to international RIs, the initiative has enhanced the attractiveness of the Norwegian institutions for cooperation on high-quality research projects by strengthening the research environments.

4.1.7 To what extent does the initiative contribute towards reliable long-term storage and archiving of research data, as well as increase the accessibility and reuse of research data in keeping with the FAIR principles?

The main contribution so far has been the funding of Sigma 2, several databases related to RIs, data management integrated in all RIs, and the introduction of policies such as the FAIR guiding principles across RCN's funding landscape. Norwegian involvement in international initiatives has been important for this development. Lately the involvement in EOSC has been important, and the Norwegian situation is described by EOSC⁹

9. <https://op.europa.eu/en/publication-detail/-/publication/95e4a900-2a21-11eb-9d7e-01aa75ed71a1/language-en/format-PDF/source-173316815>

as an example of good practice in how to maintain a national roadmap and coordinate RI activity around cross-cutting themes: 'Since 2009, Norway has invested in more than 30 national scientific data infrastructures through INFRASTRUKTUR. Most of these data infrastructures are also on the roadmap for national RIs which was updated in 2018. The roadmap contains RIs that are of broad national interest, unique in the national infrastructure landscape, of strategic importance for international collaboration and for the national public sector, research and higher education, and industry. RIs that include Norwegian contributions in ESFRI projects are also given special focus in the roadmap because these have key roles for Norwegian collaboration with international research. All RI projects that receive funding through INFRASTRUKTUR are required to document in their proposals that they have discussed how to coordinate their needs for generic e-infrastructures and data management with the national horizontal e-infrastructure providers and, if applicable, also with international e-infrastructure providers.'

Exactly how EOSC will influence RIs in general is not clear to the committee. Nor does it yet seem to be clear to the RIs themselves as far as we can tell from interviews. There seems to be a need for RCN to differentiate between the steps in the research process and to make sure that RIs have a good understanding of their role. The steps involved at RIs are usually

in data production, management and related services rather than in publishing of research articles.

Although some RIs appear to have data ‘management’ plans in place, there is still a general perceived lack of a clear vision and policy on data stewardship, including the longer-term provision of reusable research outputs (not only data but also software and algorithms). Although not all parts are clear at the moment, we noticed several issues during interviews which raised questions:

- Is there a need for a more pronounced policy that will ‘gently force’ RIs in the proposal and execution phase to provide and later execute FAIR-compliant data stewardship plans?
- The development and implementation of strategies for accessing data through virtual machines (topics: machine actionability, edge computing, sharing access issues) is a major new trend and will be very important for RIs, yet it only seemed to be ‘apparent’ in a limited number of the interviewed RIs. How should this be handled in already financed RIs?
- Limited and unclear funding mechanisms in the current system for developing and maintaining FAIR data stewardship, especially after project completion. Who is responsible for long-term reusable preservation and provision and for funding?
- How should the current limited funding of data storage and stewardship and lack of clear policy from the funder be resolved?
- Is RCN or any other actor ready to make distributed data storage a requirement according to FAIR principles?
- How and when will Norway be involved in EOSC? Is there a forum for RPOs to discuss and cooperate on strategic issues related to EOSC and, in this context, on RIs and EOSC in particular?

4.2 BENEFIT TO SOCIETY FROM RIS THAT ARE GRANTED FUNDING

4.2.1 General comments

With systematic quality assessment and prioritisation of RI needs for societally strategic areas in Norway, the INFRASTRUKTUR initiative has potentially many positive effects for science and society. However, the effects on society are generally of a long-term character. First of all, the RI must be established, and it normally takes a few years before operation and use for new research starts. Both establishment (upstream) and use (downstream) of the RI may have positive, though different, effects on society. The establishment of new RIs or upgrades can have significant upstream effects on stimulating certain high-tech industries to deliver advanced equipment, software or methods and can therefore act as a driver of innovation and development. There is only limited reporting available on these upstream effects from the RIs.

The impact on society through downstream use of the RIs is long-term in character, and it is therefore too early to see any major significant and clear effects of most RI projects on society. These effects can be in the form of increased impact of research on societal challenges (climate, environment, health, social welfare, etc.), development and increased competitiveness in the private sector due to research findings and cooperation, competence building, Norway’s attractiveness, etc. Although these types of effects usually have a long-term horizon, some are already evident in the processes that are underway. One of the first grants in the INFRASTRUKTUR initiative was awarded to the Ullrigg drilling test site, and was later complemented with grants to the OpenLab platform. The results from these projects are now used by Equinor when drilling in the Norwegian continental shelf and is saving costs by up to 20 %, partly by reducing its use of fossil fuels and thereby reducing carbon dioxide emissions. In the coming years Equinor expects to save billions of Norwegian kroner annually on its drilling operations. Another project that will have noticeable effects is the ZEB Lab, where components for reduced (zero) emissions from buildings are tested. This project has just started operations, and the results will not necessarily be recognised as coming from the ZEB lab once they become commercially available, but they will potentially affect the everyday life of people in Norway and elsewhere.

The portfolio contains many projects that are well suited to Norway as a coastal country with both arctic and more temperate climates and with an abundance of energy sources, both fossil-based and renewable. Some RIs monitor conditions to understand water and the seabed in the coastal zone, while others serve as testbeds for studying how to use the sea to produce food or how to capture and store carbon released when using fossil fuels. Norway has taken on a very important role as host country for the European Carbon Dioxide Capture and Storage Laboratory Infrastructure (ECCSEL), a European collaboration. Most of these RIs are long-term projects that will increase projects that are valuable to industry, such as RIs for developing manufacturing processes. Norway has a high ambi-

tion to become a digital society, and investment in e-infrastructure is vital in this regard. Tightly coupled with a digital society is eHealth, and several projects are broadly related to this ambition. Overall, Norway seems to be in a transitional phase where it is too early and difficult to value individual projects but where it is easy to see that their breadth will make Norway a country that is prepared for the digital future. RCN has had a very important part in this development through strategic decisions and rules for the grants, such as requesting openness where possible, well designed and budgeted data stewardship plans, and data management according to FAIR principles.

Nonetheless, mechanisms for developing and maintaining sustainable FAIR data stewardship and management remain rather limited and unclear. The same applies to funding for long-term data reuse. A systematic policy and approach involving all actors, RCN (RI and project funding), universities, research institutes, RIs and researchers would be necessary to potentially obtain major societal impacts in many areas.

In order to measure the impact of RIs on society, it would be necessary to develop a systematic approach to monitoring effects that is non-trivial, since although the effects may be large, at least in certain areas, they are indirect and long-term, and simple KPIs would not be sufficient. Interesting general approaches are currently being developed by ESFRI and OECD.¹⁰

10. OECD SCIENCE, TECHNOLOGY AND INDUSTRY POLICY PAPERS No. 65 ('Reference framework for assessing the scientific and socio-economic impact of RIs')

SPECIFIC QUESTIONS IN TOR

4.2.2 To what extent do the infrastructures support research addressing societal challenges?

The RCN prioritisation process includes a second part with an assessment of the strategic and societal importance of the proposed RI investments within 13 different areas. These areas are related to the portfolio boards at RCN, the thematic areas in the government's long-term plan (LTP) for research and higher education, and to other governmental strategies. This is a powerful mechanism to steer some of the investment towards RIs that have potentially major impacts on society. This also sends a strong signal to the research system about which areas applications are expected for and can be successful in. These areas also correspond to areas with considerable project funding and activity that are likely users of advanced RIs.

The largest areas of investment in RIs over the past 10 years are environment, e-infrastructure, medicine and health, nanotechnology, biotechnology and renewable energy, all of which have considerable societal impact and support basic and more applied research. It is also noteworthy that in a classification according to the LTP areas, the largest investments are in the areas 'relevant to the industrial sector', 'enabling and industrial technologies' and 'climate, the environment and clean energy'.

To conclude, a large portion of the RIs funded by RCN support conducts research addressing societal challenges.

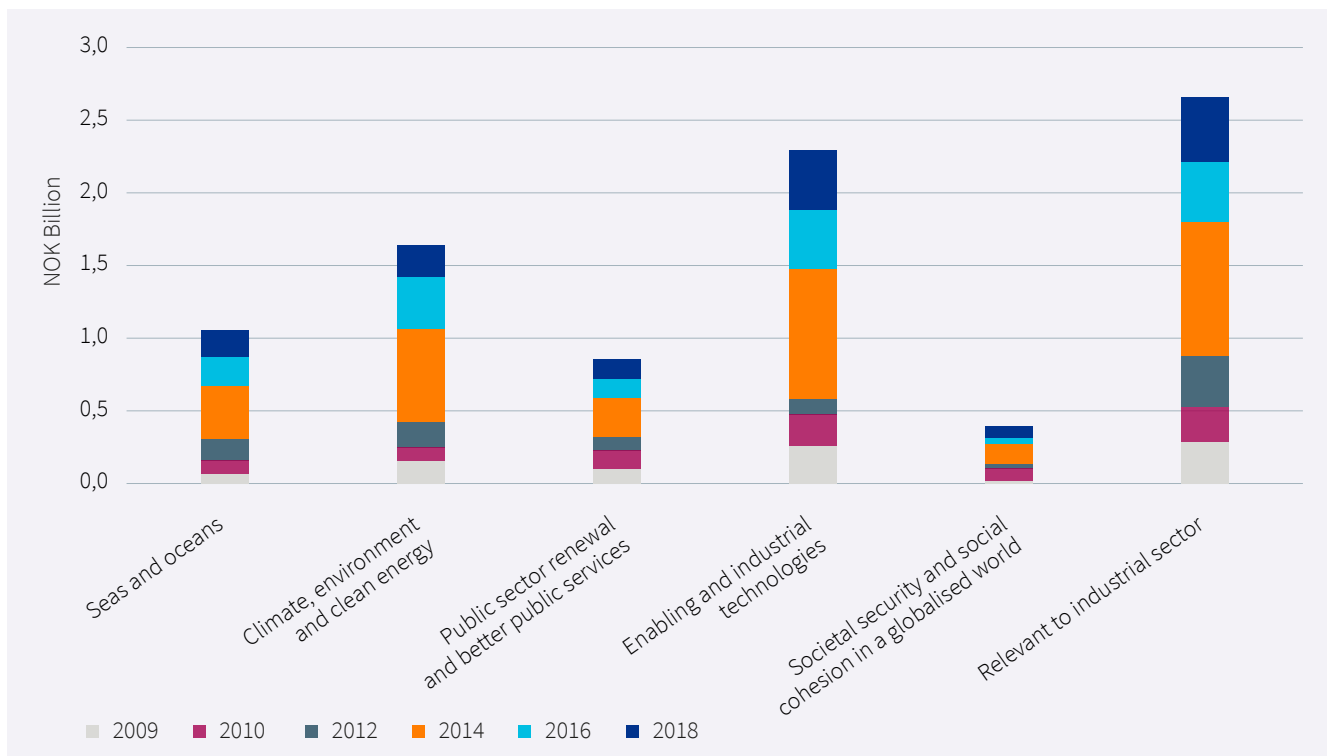


Figure 3: Funding of RIs relevant for thematic areas in the government policy for research and higher education. (Source: Research Council of Norway)

4.2.3 What role have the infrastructures played in enhancing value creation and/or innovation capacity in the private and public sectors?

The diverse nature of the RIs supported by the INFRASTRUKTUR initiative and their highly diverse use in different disciplines make it difficult to gain an overall picture of the role of the INFRASTRUKTUR initiative in enhancing value creation and/or innovation capacity in the private and public sectors.

The user surveys cite several examples of use from both the private and public sectors, but quantifying the use is impossible due to variations in the surveys. Added to this, one should not forget the indirect effects from academia and private sector collaboration, in which RIs are utilised in joint R&D projects. Such indirect effects could include unrelated projects in industry, where knowledge created in collaborative projects is used and but is hard to measure.

Based on input from user surveys, RCN and interviews, it is clear that the RIs contribute to value creation and innovation capacity in both the private and public sectors:

- In general, external use (understood as users not representing the host or partners of the RI) is common and widespread.
- The RIs are also opened to use by industry up to a certain level (in order not to violate state aid rules).
- Private sector use of RIs is also reported frequently, although no measures exist of the degree of private sector use relative to the potential for such use, i.e., keeping it within the framework for state aid rules.
- The overall picture is that the RIs are commonly used by scientists as well as bachelor, master and PhD students, showing that the RIs are beneficial not only for research itself, but also for educational purposes and competence building.
- Interviews showed that RIs directly related to industry had established arenas for collaboration with the private sector, typically within the energy sector. Private investments in such RIs also allow for more commercial use of the RI (due to state aid rules).

Regarding the private sector, there have been initiatives from industry on the use of equipment and RIs. The need is mostly for infrastructure related to later stages of development (testing, simulation, piloting, verification, prototyping), whereas RIs hosted by the universities/research institutes usually support research at early stages of development (high research content). The INFRASTRUKTUR initiative mostly finances investments in the facilities used for high R&D content, and other funding initiatives target activities closer to market introduction (higher TRL levels).

On commission from the Ministry of Trade, Industry and Fisheries, Menon Economics conducted a mapping of equipment for testing, piloting, visualising and simulation in 2016 (MENON-PUBLIKASJON NR. 41/2016). The mapping was part

of the knowledge base for the white paper on industry (Meld. St 27 (2016–2017)). The private sector had since long declared an increasing need for access to such infrastructure. The mapping showed that there was untapped potential for increased industrial use of existing infrastructures financed through public funding schemes such as the INFRASTRUKTUR initiative, and that the capacity of publicly funded infrastructures in general was not fully utilised, not even of laboratories that are of strong interest for industry. However, the mapping did not analyse how use of existing facilities could actually be improved.

Despite the untapped potential for industrial use of many RIs mentioned in the Menon report, there were serious barriers to expanding private sector use of laboratories, such as state aid regulations. This issue was also raised by several of the interviewees in the present report, particularly by those related to the research institutes. The state aid rules mean that the more public funding a RI receives, the less commercial activity is allowed. Some RIs have solved this issue by increasing the share of private investments in the RI, and thus allowing for more commercial activity. It is important to find alternative ways of resolving such situations to avoid letting potential use go untapped.

The new public funding scheme for R&D infrastructure, Norwegian Catapult, was introduced in Norway in 2017. This funding scheme is administered by SIVA (Selskapet for industrivekst) in cooperation with RCN and Innovation Norway. It funds national catapult centres that offer facilities, equipment, expertise and networks aimed mainly at testing and simulation at higher TRL levels than the INFRASTRUKTUR initiative. In general, the Norwegian Catapult and the INFRASTRUKTUR funding schemes supplement each other as they cover different stages of research, development and innovation. Although they supplement each other, there is a potential to add value where collaboration between related catapult centres and RIs are encouraged and even formalised. Such informal and formal partnerships already exist between several catapult centres and RIs and their host organisations. The Environmental Technology Scheme (Miljøteknologiordningen) is another funding scheme aimed at the private sector. It is administered by Innovation Norway, and targets innovation projects at higher TRL levels than the INFRASTRUKTUR initiative. Under this initiative, companies can apply for funding of both infrastructure (tools) and human resources related to environmental innovation projects.

Finally, the INFRASTRUKTUR initiative has no doubt had a very positive effect on aspects such as strategic and structural planning by host institutions and RI partners, as well as on longer-term collaboration within the universities/RPOs as described in other sections in this chapter.

In conclusion, the committee finds that the INFRASTRUKTUR initiative has clearly played a positive role in enhancing value creation and/or innovation capacity in the private and public sectors, though the committee cannot comment on whether

the positive effects match the potential effects due to the lack of adequate statistics. Establishing relevant and effective metrics is a challenge that will be discussed in chapter 5.

4.2.4 To what extent does the initiative help increase accessibility and reuse of research data for the private and public sectors?

All interviewed partners are aware of the high-quality standards of the data they produce. Furthermore, all interviewed RPOs/RI providers are fully integrated in transnational scientific endeavours such as current international developments (e.g., EOSC, participation in ESFRIs) or developments in domestic policies adopted in Norway, cross-theme coordination or consortia agreements. The INFRASTRUKTUR initiatives help align with the requirements derived from the introduction of open science criteria (in the public and private sectors), and they foresee mechanisms to enable trusted discovery and secure exchange of data across federated repositories/digital RIs (regardless of national borders).

All the interviewed contributors and creators of data, and all managers of data, were knowledgeable of legal and ethical issues. The interviews revealed a high level of awareness of national and international law, which in turn helps increase the extent of accessibility and reuse of research data.

However, some uncertainty in the details was expressed regarding the implementation of data reuse. This insecurity was not related to the quality of data or related services, but rather to the legal approach to access or reuse of data and increased when it came to considering linkages between machine-produced data and legal issues.

There is a general need for an improved availability of highly skilled professionals as a result of the clear adoption of Norwegian national policies in Open Science and the foreseen reuse of data for either educational or industrial related purposes. This can be considered a positive side effect of the initiatives of INFRASTRUKTUR, because it is generating a demand for new professional experts in the scientific processes, helping the Norwegian RI landscape to stay aligned with international developments. Furthermore, these developments will be enabled at capillary level through all RPOs introducing the practice of FAIR data and open science, allowing a vital environment to society and industry. Of course, consideration must also be given to the reward and the recognition for the new professionals involved.

Since INFRASTRUKTUR is related to other funding mechanisms (e.g., by RCN) one could either look for synergies with other RCN activities or identify what relates to INFRASTRUKTUR and what relates to other parts of Norwegian research and education and then adapt the funding mechanisms accordingly. Either way, observance of the recommendations should reflect this inclusive approach.

4.3 ORGANISATION OF RIS THAT ARE GRANTED FUNDING

4.3.1 General comments

The INFRASTRUKTUR initiative has provided a systematic framework for and stimulated development of strategic planning at RPOs pertaining to organisational and national goals. Development is currently at different stages of maturity. The host RPOs report that internal cooperation has improved thanks to this systematic approach. About one-third of the approximately 30 different host RPOs has more than two grants. Thus, most host RPOs that receive a grant are newcomers to organising and hosting a RI. The ways in which individual RIs are integrated into their host RPO vary substantially. The impression gained from the interviews is that variation is greatest in the universities and is due to their organisational structure, with relatively autonomous faculties with different cultures depending on discipline and history. The roadmap from the University of Oslo is a good example of how a university tries to overcome cultural differences at faculty level and have both a common strategy and common central funding for RIs. This is a welcome development, because the level at which strategy setting happens in universities often seems to be too low.

How RIs are embedded into their host RPO influences their strategies for cooperation with other partners, operational funding, upgrading and/or stepwise implementation. Relations with other partners also involve some extra complexities to deal with in the case of international RIs. Operational funding often came up as a general problem area in the interviews with RIs.

The division of responsibility for RI means that, whereas RCN provides funding for investments, operations must be funded by the host RPOs, usually through base funding, taxation of research project funding or through direct fees from users. Because research institutes receive far less base funding than HEIs, they have problems ensuring sustainable operations and managing periods with less project funding. That said, base funding for HEIs is often divided up among faculties and institutions and can become too small to provide a buffer for RIs, at least for the smaller entities.

To compete for research funds in areas where RIs are important, access to the best RI is a competitive advantage. One of the research institutes expressed this as follows: *'Success in international competition in general, and in the European framework programmes in particular, would not have been possible without the INFRASTRUKTUR scheme.'* There is also the problem of the differences between timelines for RIs, which normally last for 15–20 years or even more, and timelines for research project grants that use the RIs, which normally last for three to five years.

Interestingly enough, both HEIs and research institutes mention the risk-taking aspect of setting up a new RI. One of the HEIs commented: *'There is a substantial risk involved when hosting large national infrastructures. For several infrastructures, a substantial fraction of the running costs is largely independent of the volume of use. This means that if the use for some reason drops suddenly, these infrastructures will encounter severe financial difficulties. This may happen due to lack of funding of user projects, e.g., through political shifts in financing of research and/or changes in funding programmes or a shift of focus between basic research and innovation-driven activities. Financial uncertainties also lead to temporary employment, which is not in line with the Government's policy for permanent positions in the university sector. These risks must be evaluated and constantly monitored by the institutions involved. It is also important that RCN challenge the institutions on this point and include it when evaluating new investments that increase the overall national risk. For existing national infrastructures, a continuous reinvestment may be required to keep the infrastructures at the state-of-the-art level. The current RCN funding structure is unable to handle such reinvestment without the help of new investment funds. This means that there is a clear risk that valuable knowledge and networks can be lost, also in infrastructure projects that deliver on all measures, since the total amount of requested funds will increase and the funds available are too limited.'*

This comment can be compared with one from an institute: *'The infrastructures are primarily supported by allowing more applications to be sent based on the infrastructure's capabilities. Economical constraints mean that most of the infrastructures need to be fully self-financed through projects. In some cases, operation of the infrastructure is supported financially for shorter periods. If the infrastructure is unable to generate enough income to support its own operation directly, it will be closed in favour of areas where it is possible to obtain more support from RCN, EU research funding and industry. When possible, the infrastructure funded by INFRASTRUKTUR is also included in the administration of existing activity and infrastructure so as not to add administrative costs. This also influences the choice of infrastructure to develop. The infrastructure must be aligned with ongoing activity.'*

These three statements and other responses in questionnaires point to an interesting aspect, i.e., that the organisations (as hosts or members of a RI consortium) need to initiate and support RIs in the areas that are strategically important to them. Then, due to the scientific and societal/industrial needs, the organisations would be more likely to continue funding of RI once RCN funding was no longer available. The request for operational funding is a strong driver of quality in the research projects using the RIs by forcing RPOs and their researchers to seek competitive funding. It is thus interesting to note that when the initiative first started it was the need for equipment that was the driver. This was even reflected in the title of the RCN strategy (Tools for Research). After 10 years it might be more appropriate to change it to something like 'Enabling World-class Research'. This is also more in line with the discussions in ESFRI mentioned in chapter 3: *'RIs must be viewed not as stand-alone installations, but as part of the broader system contributing to the longer-term development of research and innovation.'* In line with this observation, it would be more important to discuss how the host RPOs could better balance the risk than to discuss moving the operational funding somewhere else in the system, such as to the INFRASTRUKTUR initiative.

The model with operational funding through projects is, as far as we can understand, based on the assumption that operation of a RI is matched and largely funded by current use. There is a class of RIs where future use is an important part of the motivation for the RI. These are usually databases coupled with monitoring devices to build time series or longitudinal databases in social sciences that require continuous operational funding over a long time, but where the business model makes it difficult to directly charge projects for the use. This creates a special problem that RCN probably needs to discuss together with the host RPOs. This class of RI may also have international use with other rules for funding which could add to the complexity of the problem. Since this class of data infrastructure is also likely to be part of the future EOSC, RCN should take it into account in discussions with the host RPOs.

When it comes to leadership, we noticed a generally high level of professionalism during the interviews. We like to stress the complexity of leadership of RIs. The evaluation of the Centres of Excellence states that 'strong but dynamic leadership and team management that creates interaction within a framework' is one of the key factors for success. To build world-class RI you need not only an excellent scientific understanding but also excellent project skills to be able to build on time and on budget, whereas during operation users and their needs will be in focus and add to the skills required to lead a RI.

Through the INFRASTRUKTUR initiative RCN has taken further measures to stimulate the coordination and structure of the Norwegian RI landscape in dialogue meetings and workshops with the institutions. These initiatives have generally been appreciated by the institutions as constructive and useful. However, the interviews also indicate that there is potential to further develop the dialogue to address strategic issues, further cooperation and best practices for handling RIs, including management issues, etc. to further strengthen RIs and Norwegian research. This is a challenge that will be discussed in chapter 5.

SPECIFIC QUESTIONS IN TOR

4.3.2 To what extent are the infrastructures tailored to the needs of the users (openly accessible, responsible management of data and results, relevant over time, adequate technical expertise among personnel, etc.)?

The RIs generally appear to have an ambition to provide good and relevant open services to the users, and have taken measures to be openly accessible, manage data in appropriate and responsible ways, make relevant upgrades when necessary, and have adequate technical expertise. However, large differences exist between the RIs, depending on maturity of the RI, working traditions in the field, and available resources for operations. In most cases the level of technical support to the users appears to be adequate.

Long-term storage of the large and diverse data sets produced through the INFRASTRUKTUR initiative is no trivial issue. Especially when offered in high performance reuse environments, adequate data management during the research project is necessary, but not enough. When a study is conducted it should consider whether the resulting data have reuse potential beyond the project and as a basis for review and reproducibility of the results.

Hence, as a first step we suggest introducing the use of the term **data stewardship** rather than data management as a broader concept, including long-term aspects. In addition to the sheer size and complexity of data, the use of computational methods to discover patterns in those data sets and the rationalization, for emerging hypotheses requires data to be machine actionable wherever possible. This 'machine-actionability' is laid down in the FAIR¹¹ principles.

As emerged in the interviews, most legacy data are not FAIR-compliant, creating significant losses for society and having a severe impact on the reproducibility crisis¹². Hence, better data stewardship will not only mitigate reproducibility problems and make machine assistance for science much more efficient, it will also save substantial amounts of research funds.

11. <https://www.nature.com/articles/sdata201618> and <https://www.go-fair.org/fair-principles/>

12. See for instance: <https://op.europa.eu/en/publication-detail/-/publication/d3766478-1a09-11e9-8d04-01aa75ed71a1/language-en>

Without making any increase in the overall investment in research, RCN could free up budgetary resources by requiring FAIR-compliant data stewardship, which would represent an average of 5 % of the RI budgets. It is anticipated that demanding proper data stewardship from RIs and asking RCN to budget properly for long-term reuse of data for future projects could facilitate long-term sustainability of RIs that provide such data.

For several RIs, the committee noted a rather limited national use by other RPOs, and they operate mostly as in-house core facilities for the host RPOs. There are several reasons for this:

1. the largest user community is often located at the host institution
2. proximity effects, i.e. more convenient to use on-site facilities
3. travel and time costs for non-host users on top of user fees of the RI
4. user fee models that favour internal users e.g., the institution has subsidised use by internal users.

It is also clear from the interviews that hosting a RI is often regarded as highly advantageous by the hosting institution since it provides several positive effects, given that it matches the research activities of the institution. Benefits that were expressed include strengthened opportunities and increased research quality for the local research community due to the proximity of the RI, increased competitiveness for research grants both nationally and internationally, attractive for international and national research collaboration, competence building and education.

Host institution benefits are often a concern for the non-host partners. Since cooperation between institutions and the pooling of RI resources are important parts of the INFRASTRUKTUR scheme, this issue will need to be considered in the contracting and follow-up phase. The incentives for host institutions to develop the existing RI for increased external national use are coverage of the operating costs and future applications for new RCN funding for larger upgrades. If these incentives are not strong enough, there is a real risk of the RI gradually serving internal users only. Some RIs suggest that incentives for ensuring wider national use could be to support travel expenses and mobility/exchange of staff or scientists. This would improve the attractiveness of being an active partner and endorse collaboration instead of competition.

Several of the RIs could pay more attention to simplify and stimulate use from external users. It would then be important to try to handle possible barriers to use, such as geographical distance (remote access or simplify travelling) or user fee models that disadvantage external users, and actively promote user interactions by, for example, establishing user fora.



Nobel prize winner Edvard Moser (in the middle) together with colleagues and a rat with the new Neuropixels 2.0, funded by the INFRASTRUKTUR project NORBRAIN3, on its head. Neuropixels 2.0 is a tiny silicon brain probe, which contains several rows of even smaller microphones. After decades of being limited to single cell recordings these super-small microphones can listen to conversations between thousands of brain cells across one or more areas of the brain. The data the probe registers is the activity that itself gives rise to our intellectual abilities such as learning and memory.

Photo: Rita Elmkvist Nilsen /- Kavli Institute for Systems Neuroscience

4.3.3 To what extent are infrastructures granted funding that is financially viable/sustainable?

The Norwegian approach to tackling this is a competitive peer review and strategic prioritisation process conducted by RCN to select the best RIs to invest in for high-quality research. The operations are then assumed to be covered by the RPOs and users, which essentially is a research market approach: the RIs that attract sufficient users and/or institution support, i.e., are competitive and needed by users, will thrive. This system provides good opportunities to clarify the real costs of the RIs and to weigh them against their benefits.

This approach has clear advantages that are also evident from the background material and the interviews. The institutions develop prioritisation schemes for RIs that are closely connected to research strategies and the ability of the institutions and of their research communities to bear the operations costs. There are also risks, some of which are discussed in the general section of this chapter. There is a need to balance

the risk of losing project funding against the availability of some base funding.

There are several successful RIs serving large research communities that have been able to attract successive INFRASTRUKTUR grants for continued build-up of research capacity, and for these RIs the initiative has been a predictable and sustainable, though also highly competitive, source of investment in larger upgrades. They generally also attract sufficient institutional funding and external funding, for example through user fees, for their operations.

As was expressed in several of the interviews, this approach also has challenges:

- Upgrades and reinvestments of existing RIs may take a long time and depend on successful applications in competitive calls. Thus, there is a risk of loss of initial investments if the reinvestments take a long time and the RI fails to stay competitive and provide the services the researchers need. On the other hand, the host RPOs may also plan for the upgrades using institutional grants, user fees and/or joint investments with other RPOs or industry.
- Attracting sufficient operations funding for many of the RIs and particularly to include smaller upgrades and replacements of spare, etc. to stay competitive. This is to some extent a cultural issue, i.e., use of equipment is often provided with no cost for access and then the actual costs are not evident to the users. But it is also an issue depending on other parts of the research funding system, e.g., the extent to which research grants normally include funding for researchers' use of advanced RIs. RCN allows for research project applications to include RI user fees, but it appears that the funding system and the researchers have not yet fully adapted to this approach.
- Some RIs, for example within the humanities or climate fields, report that what they offer is regarded as common goods among users, and thus there is no willingness or established model to pay for their use.

The opportunities for financial long-term self-sustainability vary substantially among the RIs, depending on type of research (applied/basic), discipline and character of host RPO (university/research institute). The host RPOs vary widely in their ability to establish sustainable cost models between universities (governmental basic funding of about 70 %) and research institutes (governmental basic funding about 7–8 %). Due to this fact, universities have more flexibility when it comes to covering staff salaries, use of technicians, maintenance costs, etc., whereas the research institutes must cover almost all operating costs through user fees from projects. Although this is the normal financing model for external projects at the research institutes, the dependence on shorter term projects limits opportunities for the research institutes to take on long-term responsibilities for extensive RIs.

It is normally easier/less challenging to establish sustainable funding models for operating costs for RIs supporting applied research and/or research with industrial partners. In this context, the costs of using RIs are included in research projects (these projects are often funded by RCN, such as IPN projects or Centres for Research-based Innovation (SFIs)). Research institutes that are not tightly linked to a large university or that have a larger extent of science/basic research use of RIs and/or a higher proportion of customers from public authorities (e.g., producing knowledge bases related to climate change) seem to struggle more to cover the running costs of RIs. There are no mechanisms in the application/criteria that seek to compensate for this difference.

Several aspects of the sustainability of the INFRASTRUKTUR scheme also emerged in the interviews. In many cases these are issues which RCN should address in dialogue with the other actors in the research system.

- Several of the interviews expressed concern that over time the system may not be able to bear the funding for operating costs for the increasing number of RIs that results from the investments. Can all RIs realistically find sufficient operational funding within the system, i.e., through user fees, institutional funding or research project funding? The balance between investments, upgrades and operations in the system may have to be adjusted. On the other hand, if prioritisation at the institutions works well in relation to the INFRASTRUKTUR scheme, this may be self-regulating.
- Apparently, the overall funding mechanisms and the organisation of the research system seem not to be optimally adapted to the evolving data management opportunities and requirements, which is a big barrier for seriously introducing the FAIR concept broadly. A compulsory part of the funding could be set for data stewardship plans for each RI.
- The challenge with operating costs also affects the RIs' role as international RI partners. The lack of long-term stability in the RI makes the RI more vulnerable in a European context if it must make long-term commitments. Several RIs find that the requirement to charge full-cost user fees impairs their attractiveness for international use, since many other countries have different funding schemes where the user fees are lower due to various subsidies.

4.3.4 Is there optimal use of the infrastructures in the operational phase and are they being run efficiently?

Since the INFRASTRUKTUR initiative has only existed for about 10 years and it takes some years from application to operation of equipment, only a small fraction has been operating for some years under the new initiative while a larger fraction has relatively recently started operation or is still being set up or constructed.

Several of the RIs, typically established several years ago, have broad user bases from different institutions, industry and academia, and appear to be run efficiently. Others have large potential to broaden their user bases and become more nationally relevant. Many of the newer RIs have not yet fully developed their user bases nationally and could of course be run more efficiently when they mature and the user bases increase.

In general, there is potential for most RIs to better stimulate mobility and develop remote user services to be more efficient. This could also benefit industry and student users, as well as other partners according to definitions of open science (e.g., citizens) or possible transnational partners.

Several RIs report on joint use of RIs by academic and industry researchers, and this was felt to be very useful and stimulating for both categories. This should therefore continue to be encouraged.

The managers of the RI are generally skilled, but vary widely in experience, skill and approach to providing RI services to a broad research community. This is natural in view of the broad variation in maturity of the RIs and in research fields. However, in several cases it appears that the management of the RI clearly has potential to improve. A national training initiative for RI managers (such as the RAMIRI¹³ initiative for European RIs) could stimulate further improvement in the efficiency and use of the RI.

What was said in the beginning about it being early days for many RIs also points to the necessity to monitor their development over time. How to do that is a challenge that will be discussed in chapter 5.

4.3.4.1 What distinguishes the organisation of the particularly successful infrastructures (high degree of utilisation, financial sustainability, exciting/important results)?

The RIs with high degrees of utilisation, financial sustainability and exciting/important results are often those which:

- Have existed for some years and been timely upgraded, have high technical expertise and have had the time to mature and therefore be able to develop high-quality services.
- Are important for a broad user base that also participates in the development of the RIs.
- Have strong proponent research groups with substantial external funding, e.g., centres of excellence or EU grants, to which the RI provides essential high-end research tools and services. These groups can provide substantial financial sustainability, at least for some time, and can also demand or contribute to the development of the RI for various calls for funding (also INFRASTRUKTUR) to enhance the capability of the RI.
- Have a visionary and experienced leadership that can manage the implementation of the RI, including establishing a highly skilled team of different experts to run the RI, establish excellent contacts with both the research community and the leadership of the hosting and partner organisations, and an excellent understanding of the role of the RI in the research system.

4.3.4.2 What distinguishes the organisation of the infrastructures that function less than optimally?

The RIs that function less than optimally lack one or more of the features described in the previous section.

13. The RAMIRI project produced a handbook that is still available. It focuses on RIs at European level but also contains useful information for national RIs: <https://www.ceric-eric.eu/project/ramiri-handbook/>

4.3.5 To what extent do the infrastructures reflect and follow up the research strategies and ambitions of the host institutions?

The interviews showed that many of the RIs are aware of the strategic landscape at the host institution, and both the RIs and the host institutions are generally reflecting on the national strategic priorities. The RIs are dependent on the support of the host institution for establishing a working operations funding model, which in turn is closely connected to the strategic priorities of the institution.

4.3.6 To what extent do the infrastructures that are granted funding collaborate with other relevant national and international infrastructure?

Some of this type of collaboration goes through individual researchers either in the form of collaborative projects or more network-like contacts, and this is very important for problem solving and understanding developments in the field but are difficult to quantify. Other more structured collaborations are the ESFRI-distributed RIs with nodes in each member country and large international single-site RIs where Norway, like many other countries, has national labs, or equivalent facilities, to support the use of the RI and sometimes development of the RI as well. The impression from the interviews and background material is that this kind of collaboration is well developed. It is still early days for many RIs, and it will take time for the ESFRI projects in particular to show their full potential.

4.4 ORGANISATION OF THE NATIONAL FINANCING INITIATIVE FOR RESEARCH INFRASTRUCTURE

4.4.1 General comments

The organisation of the INFRASTRUKTUR initiative has been successful in allowing Norway to have a process where bottom-up proposals from the research community meet top-down strategic prioritisations. One of the most important achievements is the internationalisation of Norwegian research that has taken place with the help of membership in ESFRI projects. This success is due to a systematic and well-thought-out general model where the main actors (government, RCN, RPOs, RIs and researchers) have relatively clear roles in the system. This model was introduced at the start of the initiative and has proven flexible enough to survive without major changes. The Norwegian model is relatively unique in the European landscape, which makes comparison difficult. Still, most of the comments show acceptance of the framework for the process and a high level of trust in RCN. Several also mention that the level of support they get during different stages of the process is helpful and satisfactory.

One impression from the interviews and background material is that research institutes seem to be more used to strategic prioritisation processes while especially university researchers have more experience from and trust in peer review processes. The first example below comes from a research institute and the second from a university.

ECCSEL has implemented, operates and develops a distributed, integrated European RI based on a selection of the best research facilities in Europe for carbon capture, transport, utilisation and storage. This ESFRI Landmark, which established in 2017 a self-standing legal entity - an ERIC, has its statutory seat in Trondheim, Norway. ECCSEL is expected to grow both in terms of new Member Countries and new service providers as well as heavy investments in upgraded and new facilities.



Image: NTNU

‘In Norway INFRASTRUKTUR provides projects where collaboration is significantly promoted and supports reducing the negative effects of the research competition model. While research competition is important for the quality of Norwegian research, its bottom-up nature limits in several ways our capability to mobilise competences towards solving important and urgent grand challenges (top-down). National RIs may provide a way of reducing this limitation by providing important common facilities and promoting cooperation.’

‘The scheme sets too many generic requirements, e.g., demanding usefulness for basic research, for applied research and for industry, and for addressing societal challenges. When all these requirements are applied for all applications, scores are averaged out and the final selection becomes arbitrary (or even political).’

Many comments address the second part of the application review process where most of the strategic component is assessed. ‘Notably, the way the research councils consider and score the relevance of the proposals could be more transparent, including the specific role of roadmaps and other strategic criteria. We propose an even stronger involvement with the research community and with other stakeholders in the further development of roadmaps and strategic documents that will have specific roles in the criteria for selecting proposals.’ This could partly be due to a communication problem, but it seems to be located in the RPOs. Some responses praise the communication from RCN and the possibilities to be involved in the roadmap process while others mention the lack of the same. It seems that the latter category is too far out in the system to have first-hand information to guide their understanding of the process. The lack of transparency, however, is mentioned too often to be described solely as a communication problem. During the interviews views were expressed that could be interpreted as lower trust in the administrative part of the process than in the peer review part. This is not uncommon among researchers, and the increasing

use of strategic discussions in the RPOs will probably increase understanding of the strategic aspect of RI funding.

SPECIFIC QUESTIONS IN TOR

4.4.2 Is the allocation mechanism under the initiative constructive (frequency of funding announcements, application procedures, use of roadmaps, etc.)?

It is extremely difficult to optimise a common allocation process, given the large variety of RIs that is needed. RIs come in a variety of sizes and project shapes, some are built from scratch, almost like a research project, while others are more like directly integrating several commercially available equipment. Some are long-term workhorses for the research while some could be built around disruptive new technologies. As important as the actual frequency of calls is the stability of recurring calls over years for predictability and efficient planning at RPOs and RIs. RCN has shown the necessary stability and sustainability of calls over the 10-year period we discuss.

Timing is often mentioned as a problem in the background material and during interviews. There are several aspects to this. One is the alignment of the Norwegian biannual process with other processes, especially international ones. The possibility RCN gives to get pre-projects in an open call is at least partly a solution. The risk of losing competitive advantages is mentioned by some. The biannual process with relatively low success rate could easily lead to delayed investments in RIs that are needed to stay competitive. This problem could be more pronounced at research institutes with low base funding and

fewer opportunities to bridge an unsuccessful application process. A third problem with biannual calls is timelines with international developments and high-risk high-gain investments. There may be windows of opportunity that are missed in these cases, but they are probably rare. They may become more common as Norwegian research becomes increasingly competitive and could be a matter of concern in future. In essence, any allocation mechanism for RIs must have compromises, and the INFRASTRUKTUR initiative has found one that has been successful in building RIs in the Norwegian research system.

Application process

Both the background material and the interviews show that the application process generally functions very well and forms a good background for informed and justified allocation decisions. It has been the backbone of seven calls without major changes, which shows the robustness of the process.

During the interviews the committee noted some comments regarding the difficulty in communicating the role of the initiative in the system, the complex rules for applications, and how to use the roadmap when applying it to the INFRASTRUKTUR initiative.

- Some universities or institutes interviewed are concerned about the significant investment of time needed to submit an application to INFRASTRUKTUR calls. This seems to place an unduly heavy burden on the human resources of smaller institutions.
- Some of the institutions have proposed setting up an initial selection round based on shorter applications than at present, so that only the projects with the best chance of success would have to prepare a substantial application.
- Changes can be made to the call up to only six weeks before the deadline, which might cause problems, especially when many partners are involved in an application.
- Due to increased internationalisation of personnel at the RIs, it was suggested that information should be published in Norwegian and English simultaneously.
- Several mentioned the possibility for smaller RIs to apply every year; a fast-track application for smaller, less complex RIs.
- There was some critique relating to slow processes in the evaluation and selection phases and in the phase for awarding the final contract.
- The types of RI projects for which RCN covers operating costs could be better communicated. The RIs that have received support for operating costs were happy about it.

Evaluation process of applications

The RIs and the institutions consider the peer review process of the evaluation (first part) to be transparent and to a hold high quality.

However, the interviewees repeatedly stated that the final administrative decision-making process (second part) lacks transparency and information on how the decision was made. Some RIs felt that the positive decision was a lottery, since the reasons behind the second step of policy-related evaluations and decisions are not known by the RIs or host institutions, e.g., what strategic issues mostly influenced the decision (important strategic areas, societal impact, industry relevance, regional politics, etc.). A clearer motivation for the final decision is sought for by many of the interviewees. The committee recommends that the transparency of this part of the decision process should increase, e.g., through clearer communication on the process and the criteria of this step and through feedback with clear motivation as to why the decision was positive or negative relative to the criteria.

Some of the interviewees suggested that basic science RIs vs RIs supporting applied science should be handled separately in the decision-making process, since the purpose and character generally differ and several of RCN's criteria may not be relevant for the basic ones.

Outlines

The general idea behind the pre-application step (outlines) appears to be relevant and good. It provides opportunities for coordinating or merging RI initiatives, avoiding duplication and competition. Most RIs/hosts also supported the idea of the outline procedure, although it requires additional work. Representatives of some RIs mentioned time-consuming and difficult competition between small actors who do not have the critical mass on their own. It was suggested in the exchanges that a procedure managed by RCN be developed that would allow the pre-proposals of the various stakeholders to converge before the call for proposals ('strengthen cooperation rather than competition'). In essence, some RPOs would like to see more involvement by RCN in the pre-proposal coordination.

Roadmap

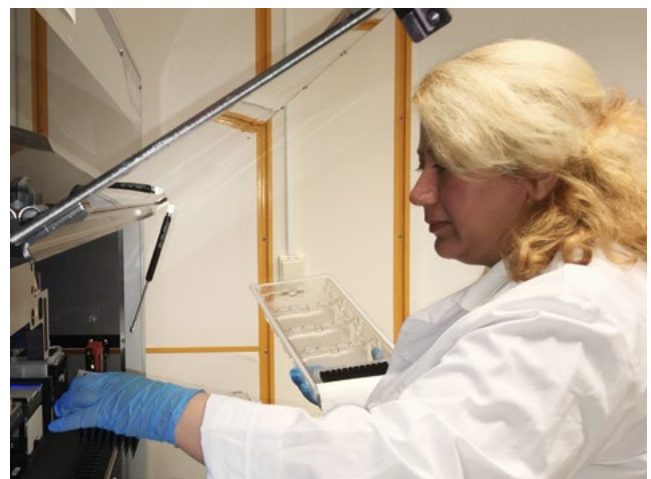
The roadmap has served both RCN and RPOs very well to increase the stability and predictability of the INFRASTRUKTUR initiative. For both RCN and RPOs it has also been a way to foster inclusion of RIs in strategic thinking about research development in different areas.

- Some positive statements about the benefits of the roadmap
- Very good overview of current RIs and those that may appear to be in the pipeline.
 - Good start to use the outcome of the previous application round as an important backbone of the roadmap.



Several RIs have been active in the fight against the covid-19 virus, among them The Norwegian Consortium for Sequencing and Personalized Medicine (NorSeq). This RI provides cost-efficient high-throughput DNA sequencing analyses to facilitate the development and implementation of personalized medicine, and its facilities have been used, among other things, to identify covid-19 virus variants.

There is an important discussion to be held about roadmaps. RIs have become such an important part of research development that RI roadmaps also tend to become roadmaps for research development. This means that the RI roadmap touches on and interacts/competes with other research strategies. The current roadmap is relatively streamlined to contain input from the application process, presenting large-scale RIs of national importance, which have either received funding or are considered as “worthy of funding” by RCN. This seems to be an overly narrow (and national) focus and the roadmap becomes more like a comprehensive list of all the addressable themes than a strategic document. It could be more useful as a strategic document if it included an analysis of larger international trends and, accordingly, opportunities for and threats to Norwegian research and industry; i.e., in what areas do we need to strengthen efforts to maintain or expand competition capacity through the use of RIs? Another aspect is how to handle rapidly developing system-wide needs like data management/data stewardship. The described development can also be compared to the ESFRI development of roadmaps.



Photos: Lars Petter Devik

Evaluations and follow-up of grants to RIs

Although follow-ups of grants are already in place during the RCN grant period, there seems to be a lack of national evaluation of the RIs in operations, which in turn leads to a lack of strategic advice to institutions on competitive development and/or closure of the RI. One example of how to do this could be for RCN to develop a framework for evaluation when 80 % of the contract period has elapsed (calculated from a five-year RCN grant and a 10-year contract, which should give at least three years of operational experience). The host RPO could be responsible for the evaluation and report back to RCN, which could analyse and summarise the findings to the benefit of the whole system. Since the contract spans a longer period than the investment funding, this could be a commitment from the RPO in the contract that does not require any further funding beyond the original decision. The committee would also have liked to have a set of KPIs in place to better assess the implementation of projects with grants from the initiative.

4.4.3 Are the infrastructures granted funding of national importance or of more benefit to individual institutions?

The simple answer is that the funding is of more benefit to the host, because skills development is highly dependent on daily exposure to the RI and the various problems that arise and are solved through the daily work and through contact with users. A well-functioning user support organisation can, at least partly, solve this problem.

A more complex answer takes the large differences between the various RIs into account. Some of them have grown and developed from a large research environment, and the INFRASTRUKTUR initiative created an opportunity to expand the capabilities and capacity and open the RI to other national users. This has been successful in some cases, but in others the RI has mainly been used and been the interest of the host research group. It should be noted that in some cases this could be the result of how the RI access of the users is financed, while in other cases it just could mean that there is a nationally leading and dominating research group. The mode of access could also be quite different, ranging from users needing full support to users with their own expertise to operate the RI or those only accessing FAIR data. Scientific use can sometimes be described as a collaboration with many specialties involved and a multitude of benefits created. To better understand these interactions and possibilities, we would recommend using the evaluations presented in section 4.4.2 above.

4.4.4 Is there a sound balance in the distribution of allocations to different areas (for instance: thematic vs generic (more to e-Infrastructure?), national vs international, upgrading vs new investment, establishment vs operation, established vs starter communities, more to fewer infrastructures vs less to more infrastructures)?

This is perhaps the most complex and difficult question to answer. As always, what a sound balance should be is in the eye of the beholder. From the committee's perspective the initiative has been successful in transforming Norwegian research into the current situation, with overall better competitive strengths, more strategically relevant investments and a higher degree of internationalisation. Nevertheless, we note that the INFRASTRUKTUR initiative funds RIs in all the strategic or prioritised areas. The balance also depends on national priorities funded through other routes outside the INFRASTRUKTUR initiative (direct funding by ministries to RIs in certain areas such as energy, climate, health). Several of the balances mentioned above are also touched on in other answers to questions in other sections in chapter 4 and will not be repeated here.

The initiative cannot solve everything, so there is a need to look at the bigger picture. Without a clear picture of the research landscape, both nationally and internationally, it is not possible to discuss balance. The way the roadmap process is set up in Norway, it should be possible. The committee noticed that there are more thematic groups giving input to the roadmap compared to groups with a basic research focus. This needs to be monitored to avoid influencing the balance. We have identified a few problems below that need to be taken into account when balancing but do not, unfortunately, have clear answers to them.

- Is the total size and/or needs of RI investments balanced by availability of operating funds (project funding (restricted to national funding or also including international funding) or base funding to RPOs)? Are new initiatives for thematic research balanced by increase in funding for or strategic input for associated RI investments (and vice versa)?
- Does the incentive structure in the Norwegian research system balance RPOs' desire to both invest in and operate RIs? Is there a risk that a certain balance leads to a RPO investment exit from a prioritised field?
- How is value over time balanced with short-term investments? This is especially important for international engagements in which Norway as a state is a member.

The committee has, however, seen two areas where an analysis and overview of rules and balances could be of value:

- Large-scale, international survey programmes that collect longitudinal data across countries, such as European Values Study or SHARE, constitute an important RI for social science research. Yet opportunities to fund such data collections are extremely limited and, unlike several other countries, are not defined as RI investments in the current definition used by RCN. This is a serious concern for their long-term impact and sustainability. The INFRASTRUKTUR scheme should reconsider how this type of funding should be handled in future. A deeper discussion with the research community might be needed to find better and more acceptable solutions than today.
- Given that Norwegian research has become more competitive during the 10-year period of the INFRASTRUKTUR initiative, there might be a need to be prepared for applications where innovative or scientific breakthrough infrastructure projects based on Norwegian research are proposed. These could enable Norway to stay competitive for the next 15 to 20 years. In addition, it was suggested during the interviews that a mechanism for financing pre-projects, aimed at bringing innovative infrastructure ideas to maturity, would be a plus. This could be done like the pre-projects for international memberships in an open call. One reason for bringing this up is that this type of project could easily go under the roadmap radar and a pre-project might make it easier to realise the value of the project in that context.

5. Challenges and recommendations

5.1 IMPACT OF THE INITIATIVE ON RESEARCH AND RIS Challenge

Based on the information available, the INFRASTRUKTUR initiative has clearly been a game changer. It has brought funding of RIs and the role of RIs in research and innovation up for discussion and has resulted in concrete actions and decisions. However, long-term coherent and continuous monitoring would be needed to make a more detailed assessment of the changes INFRASTRUKTUR has brought to the scientific community and to society at large. Unfortunately, this seems not to be the case, resulting in difficulties in analysing the research and innovation outputs and impacts of the funded RIs.

The initiative will now encounter several new challenges, some of them general, like the recovery from the Covid-19 pandemic and the rapid development of new technologies, others more initiative-specific, like handling requests for upgrades and more costly RIs due partly to increasing capacity needs but also to higher ambitions to keep Norwegian research competitive.

The RI upgrade cycle varies widely from one RI to another: 30 years or more for building construction, 12 to 15 years for scientific equipment and up to seven years for computer and network equipment. How soon financial pressure linked to upgrades will emerge will depend on the type of RI, its societal impact and the continuously evolving international legal frameworks. We can imagine that in a few years' time the e-infrastructure sector, which has the second-largest budget in terms of volume, will embark on a upgrade cycles that will place a significant burden on the INFRASTRUKTUR initiative. Other RIs will also have to consider digitalisation and how their equipment needs, links to e-infrastructures and service provision are influenced. The financial needs linked to upgrading existing RIs will then become a reality to a varying degree from one call to the next because it is linked to RI upgrade cycles. Therefore, it is important to avoid the financial needs linked to upgrades

from weighing too heavily on the INFRASTRUKTUR initiative and to limit capacity to support new innovative RIs. E-infrastructures are discussed separately in section 5.5. Another aspect is how to communicate the need for new and upgraded RIs and thereby increase understanding of the RIs' important role in different areas of research.

Norway has a highly ambitious international presence and has entered a number of ERICs. This situation is still new but some problems that have already emerged were discussed in section 4.1.6. These memberships are usually indefinite but with the possibility to opt out after a fixed time, and over the next 10 years the first fixed time periods will expire. Norway will have to evaluate the added value of these memberships and decide whether to stay at entry level, move to an upgraded level or to exit. Norway also hosts international organisations and will have to make sure that other countries find the added value high enough to stay in the cooperation. This will require more work than entering international collaborations. The existing exit strategy based on bottom-up case-by-case evaluation and recommendation is a good start, but the process will be more complex. Since RCN has been central in the process of becoming a member, RCN will almost certainly be as central when it comes to developing or exiting a collaboration in which Norway as a nation is a partner/member.

Finally, we identified four areas that would further enhance the impact and importance of the initiative for the Norwegian research system: handling of applications, which is already done efficiently; strategic road mapping, which might need some more work on bringing in research trends; reporting analysis and impact evaluation, which should be strengthened (see also the KPI discussion above); and internationalisation, where an increase in work related to evaluating memberships and being a host nation is foreseen.

Recommendations

RCN is recommended to develop different sets of well-designed indicators of success (KPIs and/or metrics) which would allow tracing back and analysing impacts and trends for both scientific activities and impacts on society, including innovation as was discussed in section 4.2.3. These kinds of indicators should be terminologically aligned, continuously collected and monitored. This would strengthen the impact assessment of the investments made over the years and be included in the decision process about possible upgrades of existing RIs. This kind of information would also

benefit the research performing institution in its strategic decision making to allocate its own funding for the RIs and support the development and maintenance of highly skilled personnel for the RI's operations and development. This would be a good complement to the strategy process already in place. It is recommended to build these on the ESFRI recommendations¹⁴ and align them with the forth-

14. https://www.esfri.eu/sites/default/files/ESFRI_WG_Monitoring_Report.pdf

coming KPIs to be developed in EOSC. RCN could also consider whether it wants to have indicators for the use of the RI in applied or basic research, as mentioned in chapter 2.

- RCN is also recommended to develop, together with RIs or host RPOs, a system for compiling impact stories for decision makers and society, explaining what benefits the investments have had for science and society. This would enhance understanding of the critical role many RIs play for science and society. In chapter 3 we suggest that there is a window of opportunity to use the Covid-19 pandemic as a test case and a driver for this development. This type of communication and storytelling activity would complement the roadmap process, and the frequency could be linked either to this process or to the strategy process (Tools for Research). However, a one-time effort would soon be outdated.
- To facilitate planning, RCN is recommended to continuously monitor in accordance with the developed KPIs and introduce landscaping activities. The research system and the requests are different from when the INFRASTRUKTUR initiative was launched in 2009. If this has not been formally done recently, it would be important for RCN to carry out a new and broad inventory of Norwegian RIs, including participation in international RIs, by reviewing their long-term financial needs for upgrades. This would introduce a structured monitoring process and would consolidate a projection of the financial needs for new investments and upgrades of existing RIs into a 15-year vision. RCN would then have the necessary elements to decide whether it needs to seek to increase the initiative's budget to meet all investments (upgrades and new investments) or, for example, to exclude the subject of RI upgrade from the scope

of the INFRASTRUKTUR initiative and keep within a stable budget focused on new RIs. Furthermore, the RIs that have funding from the INFRASTRUKTUR initiative vary in size, and it is reasonable to expect that the financing already in place through the initiative will enable some of them to reach a significant size in the medium term. The question of budget sustainability could also be addressed by targeting the INFRASTRUKTUR initiative on RIs whose minimum and maximum size is limited to a narrower span than today. However, a decision to target the INFRASTRUKTUR initiative must be part of a broader decision-making landscape, involving the actors concerned with the management of RIs in service, since it goes beyond the framework of the initiative and affects the recurrent and/or overall financing of RIs. The budget programming ultimately chosen should ideally be aligned with the RCN strategic roadmap. Finally, we suggest that RCN negotiate the inclusion of this 15-year budget programme concerning INFRASTRUKTUR, even if only for indicative purposes, in the government's long-term budget planning document.

- It is recommended that RCN pays special attention to handling international collaborations in which Norway is a partner due to the complexity and uncertainty in the field, not least after the Covid-19 pandemic.

Some of the recommendations above will increase the administrative burden of the INFRASTRUKTUR initiative, but we recognize an effective administration today and believe that the benefit-cost ratio will remain high if part of a systemic support is assigned to RCN instead of being spread out. RCN currently has a unique overview of the RI landscape, and building on this is probably the most effective way to support the research system.

5.2 BENEFIT TO SOCIETY FROM RIs THAT ARE GRANTED FUNDING

Challenge

As described in chapter 4, industry is using the RIs financed by the INFRASTRUKTUR initiative to varying degrees today, but the potential for increasing the private use of RIs and strengthening the impact on industry appears to be untapped. The challenge is to continuously work for improved synergies along the interfaces of such related initiatives. The panel considers the Norwegian Catapult initiative particularly relevant, as such initiatives are aimed at funding RIs though they operate at different TRL levels.

Several of the RIs are used directly or indirectly by the private sector. When capex is fully covered by RCN, there are limitations to the commercial use of the RIs due to state aid regulations. When the RI is fully state funded, the maximum commercial use allowed for is normally about 20 %. Some of the interviewees mention state aid regulations as the main reason why they do not make efforts to involve more commercial use of the RIs. Other RIs have solved this challenge by including private funding in the capex model, thus allowing for more industrial accessibility. Such public-private partnership is most common in areas with traditionally strong links between academia and industry, such as the energy sector.

Recommendations:

- To optimise potential synergies between the INFRASTRUKTUR initiative and the newly established Norwegian Catapult initiative, the panel recommends that RCN and SIVA conduct a selected mapping of RIs to get an overview of all RIs supported by the INFRASTRUKTUR initiative that are potentially relevant to the Norwegian Catapult centres. Based on such mapping, RCN and SIVA should pursue a systematic approach to strengthening the synergies and cooperation between existing and new facilities within the INFRASTRUKTUR and the Norwegian Catapult funding schemes. As an example, the Norwegian Catapult initiative could, based on such targeted mapping, take a more active role in being a door opener between the private sector and relevant RIs. A more systematic approach to improve synergies between the initiatives could also involve the application process as a way of encouraging more collaboration in the future.
- The panel sees this action point as a way to improve the private sector's use of relevant RI facilities and thus to help solve the problem that many RIs experience in achieving sustainable operating cost models.

Environmental impact and sustainability

As part of the European Green Deal, the Commission proposed in September 2020 to raise the 2030 greenhouse gas emissions reduction target, including emissions and removals, by at least 55 % compared to 1990. It looked at the actions required across all sectors, including increased energy efficiency and renewable energy, and started the process of making detailed legislative proposals by June 2021 to implement and achieve the raised target. The 2030 climate and energy framework include EU-wide targets and policy objectives for the period from 2021 to 2030.

When the EU 2030 and the Norwegian climate target plans are implemented, they will affect how we address climate footprint challenges across all sectors, including science.

Some RIs can be large consumers of energy and contribute significantly to the carbon footprint and environmental impact of RPOs. Taking significant action on this issue requires leveraging the initial design of RIs to reduce the environmental impact of their operations. To meet Norway's medium-term climate objectives, it is therefore necessary to act now by setting up new RIs and upgrading existing ones. The INFRASTRUKTUR initiative therefore appears to be one of the ideal vectors for implementing an ambitious eco-design approach which, by means of adjusted technical design solutions, can reduce the overall environmental footprint of a RI over its entire lifespan, even if this sometimes can lead to an increase in construction costs. In addition, developing well-functioning remote services may decrease the costs and travel footprints for the users of RIs. This might further increase the number of users of RIs and thus support more sustainable funding for operational costs.

To stimulate proposals aimed at reducing or limiting the growth of the environmental impact of RIs, we recommend that RCN acts mainly on the incentive level, via a specific score on the subject that is included in the project's final score and/or a financial bonus to take into account the extra costs associated with an eco-design approach. The existence of this 'environmental bonus' requires a budgetary anticipation at the INFRASTRUKTUR initiative level.

It is difficult to establish a uniform rule for what RCN needs to be provided with in order to judge the appropriateness of the selected eco-design approach (a life cycle assessment will make sense for a large RI but will be disproportionate for a social science RI). Beyond a certain size, and therefore budget level requested from INFRASTRUKTUR, the applicant should at least be able to quantify the reduced carbon footprint of construction and operation compared with an existing RI of the same type or with the current state of the RI.

We also recommend, in order to reduce the environmental impact of the RIs, that RCN includes incentives for the development of easy remote access/control/services to the infrastructure not only to data but also, when possible, to pilot all or part of the experiments carried out. In addition, the role of the environmental knowledge produced by the RI should be described by the applicants to gain an overall understanding of how the RIs can meet climate change challenges.

Finally, it is vital that the institutions that apply to INFRASTRUKTUR are aware of the deconstruction aspect, which can ultimately represent a significant financial and environmental cost. We recommend that RCN require a strategic note on the subject in the documents submitted by applicants for evaluation along with the application. We also suggest defining and releasing an RCN-related seal, to be assigned to the INFRASTRUKTUR initiative, that is relevant in the decarbonisation process.

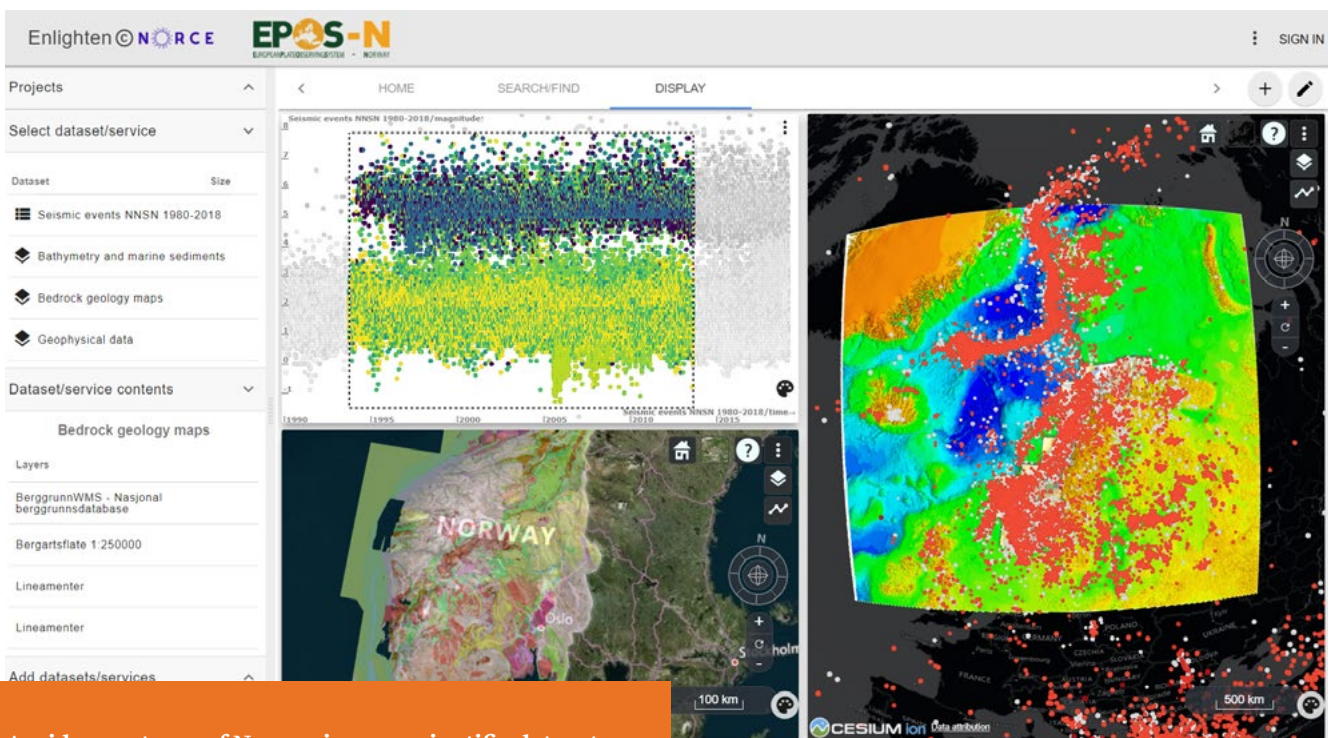


Image: UIB

A wide spectrum of Norwegian geoscientific datasets are now available through the newly developed European Plate Observing System - Norway (EPOS-N) Portal. This portal gives open access to a large number of datasets for joint analysis through advanced visualization functionalities. The screen shows some of the possibilities for pre-visualization and filtering of data available through the portal.

5.3 ORGANISATION OF RIS THAT ARE GRANTED FUNDING

Challenge

Financial and operational sustainability of infrastructures financed by INFRASTRUKTUR

RCN asks project leaders to describe the human resources planned for the operation of these RIs and to cover the necessary operating costs over time. From the interviews we conducted it is not clear whether all the RIs have in fact identified a clear organisation for the management of the RIs. For some RIs, host institutions also report a limited capacity to finance operating and staff costs in the long term. Some of them report a real difficulty in charging users who cannot afford to pay or who have more limited institutional funding than was hoped for in the original business plan. The risk is a retreat to mostly users internal to the host institution and/or underutilisation of RI due to lack of staff and operating budget.

In addition, the issue of maintaining the RI in operational condition is important for a large part of the research community to ensure the long-term development of Norwegian research. Some RIs funded by the INFRASTRUKTUR initiative will indeed need to conduct regular heavy maintenance operations; the sums involved may exceed the basic operating amounts usually allocated and are not in the spirit of funding from INFRASTRUKTUR.

Recommendations

The panel recommends that a systematic approach to the following action points be considered to enhance sustainability of the model for operating costs (opex) for the RIs in general.

- RCN should ensure that the costs of using RIs are eligible and, in a systematic and proactive way, promote inclusion of these costs in the R&D project applications across all national research initiatives administered by RCN.
- Increased use of the RIs is considered an important step towards obtaining more sustainable opex models. RCN should facilitate that, when relevant, capex models involving private investments should be pursued to optimise the private sector's accessibility to the RIs.
- Introduce cost models that include the use of FAIR data management and services for all R&D activity (in general 5 % of budgeted research project costs).
- In order to have a better understanding of the first years of operation of an RI, it is recommended that RCN facilitate a national evaluation plan according to the suggestions in sections 4.3.4 and 4.4.2. Although follow-ups of grants are already in place during the RCN grant period, there seems to be a lack of national evaluation of the RIs in operations, which in turn leads to a lack of strategic advice to institutions on competitive development and/or

RCN allows grants for R&D projects involving the use of infrastructure procured by the host institution itself to be used to cover a relative percentage of the depreciation costs of this infrastructure. RCN grants may also be used to cover operating costs for the project's use of infrastructure. The panel found that this opportunity is not used to its full extent by the researchers applying for research grants and the RIs/host RPOs by charging relevant user fees. Several reasons were mentioned by the interviewees to explain this, such as a tradition of considering the use of equipment as a 'free service' or because some RIs are used for long-term monitoring activities (and thus less organised into R&D projects supported by RCN) or because scientists simply are not trained to include RI costs when writing their R&D project applications.

It would seem inconsistent to us to ask the INFRASTRUKTUR initiative to finance as a matter of principle the operating costs of the RIs to deal with the difficulties encountered by some of them, as this would weigh too heavily on the capacity to finance investment, which is the primary vocation of the initiative. The recommendations below are directed to RCN, and in section 5.5 we will return to this issue and discuss it from the perspective of RPOs and international collaboration.

closure of the RI. One example of how to do this could be for RCN to develop a framework for evaluation when 80 % of the contract period has elapsed (calculated from a five-year RCN grant and a 10-year contract, which should give at least three years of operational experience). The host RPO could be responsible for the evaluation and report back to RCN, which could analyse and summarise the findings to the benefit of the whole system. Since the contract spans a longer period than the investment funding, this could be a commitment from the RPO in the contract that does not require any further funding beyond the original decision.

- RCN is also recommended to make an oversight of the contract when operations have started, since there will naturally be a shift from building to use/user focus in the RI. RCN should introduce the possibility of a 'post-grant agreement' to ensure or improve data reusability and services.
- RCN should also make sure that the information gathered through these mechanisms and the follow-up of contracts be fed back into the research system as discussed in section 4.3.1. We recognise that the INFRA day and other initiatives from RCN already in place can be used for this communication, but that the information will have to be packaged differently to be useful for different audiences.

5.4 ORGANISATION OF THE NATIONAL FINANCING INITIATIVE FOR RESEARCH INFRASTRUCTURE

Challenge

Based on feedback from the interviews and our evaluation of this information in the light of the overarching aims of the NFRASSTRUKTUR initiative, we find that the general application process works well and is appreciated and trusted by the applicants to be fit for purpose, being well organised and predictable, but that some aspects can be improved, two of which are considered below.

The first relates to the two-step **application process** and specifically to the first step, where applicants are requested to submit an outline well ahead of the main call. This first stage of the

process is intended to facilitate cooperation and collaboration between institutions and RIs with related ambitions and needs, and to enhance collaboration in the second step of the application process, i.e., in the main call that follows.

We find the intention for this first step valuable and that it can, if used efficiently, decrease fragmentation, increase collaboration and better serve the ambition of creating RIs with national status and serving national needs, rather than creating a competitive advantage for the host institution. In its current form, however, it does not appear to work as efficiently as it could and is often viewed as an unnecessary bureaucratic step that delays the application process.

Recommendations

We encourage more efficient use of the first step when potential applicants submit their mandatory outlines and suggest that RCN take a more active and coordinating role. This can be done by, for example, identifying overlapping or related ambitions, and by actively encouraging these actors to discuss collaboration. We also see that the outlines can be used to identify overlaps with already existing RIs. A slightly more active coordinating role by RCN would not only increase the value gained by this first application step, it will also likely enhance national collaboration and contribute over time to an altered perspective on the role of RIs where national (or international) responsibility is enhanced.

An alternative strategy is to change the application process by removing the mandatory outlines. Such a procedure would decrease costs for applicants and for RCN. However, this would likely lead to decreased collaboration across actors and loss of a valuable opportunity to influence the functionality of the programme.

The second point relates to the final stages of the evaluation process of the applications; that is, the administrative review conducted by RCN staff members in specific fields aimed at assessing national importance, strategic relevance and other potential factors, and the overall administrative assessment where projects from all fields are prioritised and ranked. This was a recurring theme in comments made by grant holders during the many interviews conducted. The content of the comments regarding this part of the evaluation process varied; some grant holders considered it too political while others, mainly those representing more peripheral institutions, called for a stronger political perspective. There was however a common critique of the lack of transparency in this part of the process. The feedback applicants receive seems primarily to be based on the first evaluation stage, i.e., the comments and grades given by the external review panels, resulting in a feeling of lack of transparency.

We recommend that RCN carefully consider how the strategic criteria used in the second strategic/administrative part of the decision-making process can be better communicated to the applicants and be better reflected in the feedback that applicants receive. This is important since it directly relates to the legitimacy of the decision-making process. From a procedural fairness perspective, it is important that all stages of the application and review process be considered as transparent and that decisions on all levels are well motivated and fair.

We further recognise the roadmap to be an important strategic tool and to be valuable for communicating the ongoing RI projects. However, we believe that the roadmap and its impact could also be further developed. In its current form it is composed of two main parts: one describes the strategic basis for RCN's priorities regarding RI in specific disciplines, thematic areas and technology areas, and the other presents a list of all the RIs the RCN regards to be of national importance from previous calls of RIs and to be 'worthy of funding'. In this way the roadmap has a strategically relevant function for future investments in RI and provides relevant information on the Norwegian RI landscape to the different stakeholders in research communities, RPOs, international partners, industry and politics. The panel finds the roadmap to be highly relevant but has identified some suggestions for improvements.

The roadmap could more efficiently address the wider international developments and trends in RIs, and the opportunities and threats to Norwegian research, society and industry. We also suggest that the roadmap be used to more directly identify areas that need further support to maintain or expand competitive capacity, for example related to green economy and digitalisation.

5. 5 IMPACT OF RESEARCH AND RIS ON THE INITIATIVE

Challenge

Finally, we take the liberty of asking a question that was not included in the evaluation questions. After having seen all the good work being done over the past 10 years, we ask ourselves how research and RIs have changed during this period.

When the initiative started in 2009 there was a general lack of equipment and of cooperation among stakeholders in the Norwegian research system. There was also an increasing digitalisation of research in many disciplines, which created a need for storage space for digital data and a growing demand for computing power.

Looking at the situation in 2021, the research system is in rapid transformation due to the accelerated digitalisation pace (not only in research but in society as a whole), a rapidly increasing demand for high-quality and advanced RIs, including necessary updates of existing RIs, and an increasingly competitive Norwegian research community with international cooperation as a cornerstone. Today there is a mechanism in place to fund RIs of national importance and a lot more understanding of the roles of RIs in the Norwegian system.

The data revolution and the EOSC initiative, with federated databases as part of the solution, are not only an answer to an ever-increasing demand for FAIR data and data storage space but are also strong drivers of change in how research is performed and organised. To make data available for reuse, FAIR data is obviously becoming the norm.

5.5.1 Organisation and cooperation in the research system and RIs

When it comes to the organisations in the research system, both research performing organisations and funding organisations, there have been fewer changes, at least on the surface. The Economist discusses the economics of government spending in a briefing¹⁵ on 16 January and writes: 'In much of the OECD the mechanisms and institutions through which governments support R&D are more or less the same as they were 50 years ago. There is a degree of ossification.' Unfortunately, they do not seem to be aware of programmes like the INFRASTRUKTUR initiative, where top-down meets bottom-up processes in a totally new, somewhat experimental, environment.

One important aspect of having a programme for funding RIs of national importance is how to handle the location of the RI and the associated host benefit. Many of our discussions and recommendations are associated with this issue. In the Norwegian system with its clear division of responsibilities between the investment portfolio at RCN and the operations at RPOs, there is a need to jointly develop this system. In chapter 3 we proposed a new forum that could be used for high-level discussions and also proposed using the structure developed

by OECD to develop a Norwegian way to optimise user bases for RIs. RCN could facilitate this development at the RPOs but need to follow the development with KPIs and evaluations as suggested in sections 5.1 and 5.3.

There is a strong interlinkage between funders and researchers in the research system through the strong representation of researchers on boards. The use of peers in many of the decision-making processes in the research system is part of what makes it a self-correcting one. We suggest that RCN should look at the limitations of the funding instrument used in the INFRASTRUKTUR initiative. Bottom-up processes resulting from calls for proposals work best when there are several competing activities of limited and roughly the same scale. For system-wide changes they are not as good as a prioritising instrument. This is now the case for e-infrastructures in the research system, since they have become ubiquitous and should be treated as a joint basic resource for research activities in general rather than as support in specific areas.

There is an understanding of this in the background material from UNINETT Sigma2: 'The allocation mechanisms have functioned very well for Sigma2. However, we are acutely aware that the large allocations given to Sigma2 are challenging the chances for other applicants. Measures have been taken to be less dependent on the INFRASTRUKTUR scheme by proposing a new funding model for the national e-infrastructure that is less reliant on this source of competitive funding.' We have noticed that the Ministry of Education and Research has started a restructuring process that might influence Sigma 2 even if we do not see the details. The recommendation below might therefore already be outdated by the time this report is published but it is still based on what we have seen in this evaluation.

Problems in funding operations are already arising with the grants awarded under the INFRASTRUKTUR initiative. This is clearly expressed by the RIs themselves. It would seem desirable to seek stronger initial commitments from host RPOs on core funding (staff, repairs and minor upgrades, day-to-day operations, skill development programmes) and make it a contractual commitment that can be followed up and used in strategic decisions about upgrades or new RIs for that RPO.

To ensure that relevant funding is put in place in scientific projects so that they can finance the costs of access to the RIs acting on the research funding system outside the INFRASTRUKTUR initiative is recommended. This would ensure that the teams external to the managing institutions of the RIs increased their share of access and thus made the RIs real national infrastructures. This is also a way to ensure that RIs are used and developed for research of high quality according to researchers needs. Since this reliance on short-term project funds has an associated risk, there is also a need for back-up solutions. This is related to the possibility to use base funding. This probably requires an analysis and overview of incentive structures, rules for use of base funding as well as size and linkage of base funding to RI hosting. It also includes rules for RPOs that are

15. <https://www.economist.com/briefing/2021/01/16/the-case-for-more-state-spending-on-r-and-d>

partners in a RI consortium. Given the range of different RIs that have already been funded, it is unlikely that one solution will fit all.

Finally, one drawback of digitalisation is vulnerability to cybercrime. This has been demonstrated during the pandemic, with hackers trying to find data on vaccine-related research. Though not always thought of as targets for cybercrime, research and RIs could easily become a target. In a way this is also related to the sustainability of RIs. Costs related to cyber-

crime could become a real burden for an RI and threaten its existence. The actual state of cybersecurity at the RIs is unclear from the background material, but if not done already, the RIs and host RPOs need to take action to reduce risk and vulnerability. This is a relatively new and growing focus area across the private as well as the public sectors, and cybersecurity expertise is not yet mature nor sufficient. Fighting cybercrime is a joint responsibility, and RCN probably has to take the policy lead on this issue when it comes to RIs.

Recommendations

- RCN play a leading role as facilitator in the response to these issues. While there are existing arenas for that we would strongly recommend RCN to develop the use of these (see also section 4.3.1).
- Take the opportunity to facilitate discussions with host organisations for RIs as discussed in chapter 3 on issues related to the development of the research system. This is not an easy task, given all the vested interests that could surface in such a discussion, but it is a way to align these with anticipated drivers of evolution of the research system and hopefully gain a better understanding of how to develop the funding and the research performing system to stay competitive.
- Investments that have a system-wide effect be funded centrally and not through competitive funding. This is of course currently related to Sigma 2, but other examples may arise over the next 10-year period. In principle we suggest that RCN's funding of Sigma 2 should not be part of the competitive INFRASTRUKTUR initiative, but we recognise that there will be future investments that might fit into the initiative.
- RCN promote an overview of incentives and base funding for RPOs to make funding of operations sustainable.
- RCN, together with the RPOs, promote training of the highly skilled people needed for operating RIs in the research system. We would especially mention data stewards as a new category that does not yet have a place in the system.
- The last recommendation relates to cybersecurity, especially the growing threat of cybercrime. The committee recommends that RCN, together with the RPOs, investigate ways to make RIs more resilient to this threat. These could include awareness raising sessions on this topic during Infra Days or including it as a topic in international collabo-

rations such as ESFRI and EOSC, or perhaps promoting educational efforts.

5.5.2 Data revolution and stewardship

Research data and data-driven science are rapidly expanding as a result of new opportunities provided by automation and digitalisation. Constraints generated by the Covid-19 pandemic have further accelerated this process. The demands for data analytics and the corresponding infrastructure, workflows and protocols have been growing exponentially in all research domains.

There are also many related issues such as open science and the FAIR data movement¹⁶ with the associated more and more important reuse of data for new science or for increasing opportunities for data and services, interoperability and reproducibility of research results, GDPR and ethics regulations which accompany data-driven research and which also have requirements on the research system and thus on the RIs. This calls for institutions to reconsider their strategy on research data and RIs with respect to accessibility and operational capacity. For this to materialise, RIs have to carefully consider FAIR data management and data stewardship.

Various aspects of research data are considered in data management, such as data ownership, privacy, security, ethics, archiving, legal and ethical issues related to data access, processing, control and reuse. Data stewardship thus encompasses all these data management issues and acts as a bridge to long-term preservation and proper provision of data for future research needs. Deriving from the use of virtual research environments, research data stewardship becomes an important and pragmatic instrument to cope with the increasing demands on data management and to maximise the usability of RIs in data-driven research activities.

16. <https://www.nature.com/articles/sdata201618>

Research data stewardship is part of modern scientific practice and focuses on responsible planning and execution of data management activities, including the collection, storage, processing and sharing of (digital) research data in trusted environments. For instance, if sensitive personal data are collected, security measures such as encryption and access control should be applied by design in the data storage solution. If commercially sensitive data are used or are to be produced in the research project, conditions for accessing or sharing data and options for data sharing RIs should be agreed in advance. It is preferable not to require researchers or RI experts to know all these requirements. (NB that the data life cycle goes beyond the duration of projects and could essentially be 'eternal'). This is where data stewardship expertise in the RIs can help enable research institutions to transform into professional data-driven organisations.

The choice of data stewardship model depends on institutional specifics, kind of research, and existing disciplinary practices, etc. Some disciplines are already familiar with data-driven research and preservation in reusable formats for long periods, such as life sciences or engineering while others, such as the arts and humanities, have adopted digitalisation more recently.

European initiatives have been working on a cultural shift towards an internet and web of FAIR data and services – and of course stewardship – within, for instance, the EOSC working groups¹⁷ and the GOFAIR initiative. A crucial step for academic organisations is to incorporate the data stewardship and pan-EU initiatives like EOSC into its current organisational model and RI strategy through institutional data strategies and driven by resulting policies. As mentioned several times in this report, the RIs funded by the INFRASTRUKTUR initiative cover a wide range of RIs in many different disciplines, basic and applied, from single-site physical data producers to databases. Not surprisingly, the committee noted a very broad and multifaceted variation in awareness and maturity when it comes to FAIR data among the RIs and the RPOs.

In general, all RIs will need to start to adapt to the new demands. Research institutions have the responsibility to provide tools and platforms that fulfil the technical demands (capacity and functionalities) of data-driven research and virtual research environments. They should also ensure the RIs' compatibility with existing and emerging national and EU policies, guidelines and regulations. It is important to be aware of and assess the status of the following challenges in managing the institutional RIs:

- the demands on RI from research communities regarding data-driven research and application of digitalisation.
- the RIs potential to cope with the emerging demands from data-driven research in terms of both the diversity of functionality and the velocity of capacity growing.
- the necessary technical and organisational security measures for RI to be compliant with all relevant regulations and policies on data reuse.
- the engagement of the research communities to shape and provide necessary training on using RI in a responsible way.
- the relevance of the legal and ethical frameworks linked to all these issues.

Regardless of the type of RI, the data management costs should be made an important and properly budgeted component in the RI design and planning. Cost developments could be managed through the introduction of preconceived and properly documented data stewardship policies. The cost of storing and curating data is not well considered in most funding schemes or institutional or RI managements. This would also lead to a need to reconsider the evaluation criteria for operating the RI.

There is a fundamental difference between responsibility for proper management and stewardship (for long-term preservation, curation and reuse according to the life cycle of data). The former lies with the researchers (or their machines) creating the data, the latter lies jointly with the data producer and the data reuser, either through humans or through machines. The responsibility for both is NOT suggested to rest with RCN, but RCN should have responsibility for developing a proper and effective policy for data stewardship so that its investments do not go to waste and science is properly served. Such a data stewardship policy should be implemented in the applications scheme criteria for receiving RI funds.

It should be imminently clear to users of 'other people's data' that further access or reuse comes with a cost, even in the case of open access. The long-term storage, the permanent access, and in particular safeguarding the integrity of data, keeping data in easy to reuse format and online, is way more expensive than just 'storage' in a repository. Therefore, if (when) RIs and research projects conducted using them generate reusable data, the costs incurred in providing these data for the estimated duration of their reusability should be budgeted and future reuse scenarios should pay a reasonable share of these costs. This is a crucial element of long-term (self-)sustainability planning for RIs.

17. <https://www.eoscsecretariat.eu/working-groups/skills-training-working-group>

The committee makes the following simple recommendations around FAIR data stewardship. The first four recommendations are general and intended for all stakeholders of the research system, including funders of projects and RIs as well as RPOs. The fifth recommendation is intended for RCN in cooperation with RPOs.

- Every investment in research should require a proper data stewardship plan that includes data management during the project. The data stewardship plans must also ensure that research data be available for access and reuse where appropriate and subject to appropriate safeguards, also after completion of the project (suggested time frame: 10 years) and also cover provisions for appropriate long-term preservation. These aspects should be based on compliance with the FAIR guiding principles.
- The responsibility for good data management should rest with the research group (which may include the RI) that creates the data.
- The long-term preservation of reusable data should rest with the creators of the data (ensure principle data reusability following FAIR guiding principles) and with the actual reusers of the data. They should be considered eligible costs in research proposals.
- Legacy data should only be made FAIR (if at all possible) once they need to be reused by others and in particular by machines.
- RCN should develop a proper and effective policy for data stewardship so that the data generated through its investment do not go to waste and science is properly served. Such a data stewardship policy should be implemented in the applications scheme with relevant criteria for receiving RI funds. The policy should be developed in close dialogue with the RPOs to ensure that the institutions implement it together with their data strategies to create a data-responsible Norwegian research system. This policy should particularly make sure that all new undertakings include a data stewardship plan or protocol that explicitly addresses data capture, management, integrity, confidentiality, retention, sharing and publication.

Appendix

1. Evaluation of the INFRASTRUKTUR initiative as a funding instrument – Terms of Reference

1. BACKGROUND

The National Financing Initiative for Research Infrastructure (INFRASTRUKTUR) was established as a funding instrument in 2009. Its overall objective is to ensure that the Norwegian research community and trade and industry have access to relevant, up-to-date infrastructure that facilitates high-quality research for an innovative, sustainable society and that helps to address the knowledge challenges facing society.

The National Financing Initiative for Research Infrastructure allocates funding to projects with a cost framework of NOK 2 to 200 million. Support is not provided under this initiative for basic equipment that several different research institutions are expected to have or for infrastructure that costs less than NOK 2 million. Decisions regarding investments that exceed NOK 200 million or international research cooperation involving major, long-term commitments in the form of investments and membership dues (e.g. [ESFRI](#)) are taken at the ministerial level based on advice from the Research Council.

Funding provided under the National Financing Initiative for Research Infrastructure is targeted towards research infrastructure of national importance. This is defined as research infrastructure that:

- is of widespread national interest;
- lays a foundation for internationally cutting-edge research;
- will be available in only one or a few locations in Norway, as a general rule;
- will be made accessible to relevant researchers and industries.

For more details about what is covered under the initiative, see the document "[What type of research infrastructure is eligible for funding?](#)". Decisions regarding funding of research infrastructure are taken in the wake of an application review process that incorporates assessments of scientific quality by referee panel(s) combined with an overall strategic assessment by the Research Council administration.

Since the National Financing Initiative for Research Infrastructure was launched, the Government has implemented an ambitious and predictable escalation plan of increases in annual allocations. Per 2019 the initiative has an annual budget of nearly NOK 740 million. Since its establishment, the initiative has allocated nearly NOK 6 billion for establishing and further developing approximately 100 research infrastructures. Roughly 80 of these have partially or fully reached the operational phase. The time has come to carry out an evaluation of the initiative

as a funding instrument to determine whether the Research Council is administering this funding in a sound, effective manner.

2. PURPOSE OF THE EVALUATION

The overall objective of the National Financing Initiative for Research Infrastructure is to ensure that the Norwegian research community and trade and industry have access to relevant, up-to-date infrastructure that facilitates high-quality research for an innovative, sustainable society and that helps to address the knowledge challenges facing society. The evaluation of the initiative as a funding instrument is to shed light on how well the initiative helps to achieve this objective, and to assess the added value of funding research infrastructure through the initiative. Findings from the evaluation will primarily be used to further develop the scheme.

3. TARGET GROUPS

The Research Council will be able to use the evaluation both to document the desired impacts of the initiative and to improve upon it.

The ministries will be able to see the impacts of the significant investments in research infrastructure channelled through the Research Council.

The research institutions will be able to use the evaluation in their strategic efforts relating to research infrastructures.

Relevant research groups will be able to use the evaluation to improve the organisation of existing infrastructures.

4. EVALUATION QUESTIONS

The evaluation will primarily focus on exploring the following:

- Impacts of the initiative on research and the research system;
- Benefit to society from the research infrastructures granted funding;
- Organisation of the research infrastructures granted funding;
- Organisation of the National Financing Initiative for Research Infrastructure.

Based on the findings, the evaluation may provide recommendations for adaptations to the initiative.

4.1. Impacts of the initiative on research and the research system

- What role has the initiative played in meeting the research community's needs for research infrastructures and services (both internal and external users)?
- To what extent and why is there use of/investment in other research infrastructures when relevant infrastructures exist under the initiative?
- To what extent do research infrastructures granted funding help to raise the scientific quality of Norwegian research (enhanced competitiveness for users in various calls for proposals, examples of ground-breaking research, etc.)?
- To what extent and how does the initiative help to structure Norwegian research and influence the priority institutions give to infrastructure?
- To what extent does the initiative help to strengthen national and international cooperation?
- To what extent does the initiative contribute towards reliable, long-term storage and archiving of research data, as well as increase the accessibility and reuse of research data in keeping with the [FAIR principles](#)?

4.2. Benefit to society from the research infrastructures granted funding

- To what extent do the infrastructures support research addressing societal challenges?¹
- What role have the infrastructures played in enhancing value creation and/or innovation capacity in the private and public sectors?
- To what extent does the initiative help to increase the accessibility and reuse of research data for the private and public sectors?

4.3. Organisation of the research infrastructures granted funding

- To what extent are the infrastructures tailored to the needs of the users (openly accessible, responsible management of data and results, relevant over time, adequate technical expertise among personnel, etc.)?
- To what extent are infrastructures granted funding financially viable/sustainable?

- Is there optimal use of the infrastructures in the operational phase and are they being run efficiently?
 - What distinguishes the organisation of the particularly successful infrastructures (high degree of utilisation, financial sustainability, exciting/important results)?
 - What distinguishes the organisation of the infrastructures that function less than optimally?
- To what extent do the infrastructures reflect and follow up the research strategies and ambitions of the host institutions?
- To what extent do the infrastructures granted funding work together with other relevant national and international infrastructures?

4.4. Organisation of the National Financing Initiative for Research Infrastructure

- Is the allocation mechanism under the initiative constructive (frequency of funding announcements, application procedures, use of roadmaps, etc.)?
- Are the infrastructures granted funding of national importance or of more benefit to individual institutions?
- Is there a sound balance in the distribution of allocations to different areas (for instance: thematic vs generic (more to e-Infrastructure?), national vs international, upgrading vs new investment, establishment vs operation, established vs starter communities, more to fewer infrastructures vs less to more infrastructures)?

5. DATA SOURCES

Existing documents:

- The Government's Long-term plan for research and higher education (2015–2024, 2019-2028);
- Tools for Research – national strategy for research infrastructure (2012, 2014, 2018)
- Norwegian Roadmap for Research Infrastructure (2010, 2012, 2014, 2015, 2018, 2020)
- Evaluation of UNINETT Sigma2 (2019);
- E-infra 2030 recommendations for updating the national e-infrastructure strategy;
- Annual reports for the INFRASTRUKTUR initiative (starting in 2012).

1. As described in the Government's Long-term plan for research and higher education 2015–2024.

Internally accessible materials (Research Council administration):

- Portfolio report for the INFRASTRUKTUR initiative 2009-2019 (statistics for infrastructures granted funding);
- Requirements and guidelines for the INFRASTRUKTUR initiative;
- Description of the application review process;
- Statistics on closed calls for proposals (2009, 2010, 2012, 2014, 2016 and 2018).

Surveys:

- User surveys regarding infrastructures in operation (user group, satisfaction, contribution to increased allocations);
- Self-evaluation of infrastructures granted funding by INFRASTRUKTUR;
- Questionnaire for institutions responsible for infrastructures granted funding by INFRASTRUKTUR.

Interview surveys (conducted by the evaluation committee):

- Selected infrastructures in operation;
- Important users of research infrastructures;
- Administrators at selected institutions that have received substantial funding from the INFRASTRUKTUR initiative;
- Research Council administration;
- Other.

6. ORGANISATION AND PROCEDURE

The evaluation is to be conducted by a broad-based scientific committee of international specialists with wide-ranging experience in the operation and organisation of research infrastructures. We expect the committee to comprise five or six experts with the following overall profile:

- A chair with wide-ranging experience in the operation and organisation of research infrastructure;
- Expertise in natural science, technology, health sciences, the humanities and social sciences;
- Expertise in e-infrastructure;
- Expertise in international cooperation involving research infrastructures (e.g. ESFRI and/or NordForsk);
- At least one member who understands Norwegian;

- Expertise in the research system/political landscape;
- Expertise in societal outcomes of research infrastructures.

The makeup of the committee will be determined by the Research Council administration in consultation with the Chair of the Executive Board.

To support its efforts, the committee will be equipped with relevant existing documents, statistics/information about previous calls for proposals and projects awarded funding. The plan is for infrastructures granted funding to carry out a self-evaluation based on selected key indicators (figures and written) including user surveys for infrastructures in operation. The committee will also conduct an interview survey of selected operational infrastructures, key users of the infrastructures, administrators at institutions that have received substantial funding under the INFRASTRUKTUR initiative, and selected members of the Research Council administration (e.g. department director, coordinator for the INFRASTRUKTUR initiative, individual responsible for ESFRI cooperation).

The Research Council is responsible for designing the terms of reference and framework conditions for the evaluation effort and may be consulted under way by the committee regarding principle and practical issues relating to the terms of reference, activity structure, limitations and any other elements in need of clarification. The committee will be able to make minor changes to the terms of reference. The Research Council will assist in organising meetings. Travel is to be planned in collaboration with the Research Council and will be compensated according to the Government travel scale.

Within its budgetary constraints, the evaluation committee will be able to make use of additional external resources and expertise. Among other things, it may be useful for the committee to have the assistance of a secretary of its own choosing when writing its evaluation report. The Research Council will also compile input for the evaluation of the INFRASTRUKTUR initiative from the national arena for dialogue on research infrastructure.²

7. SCHEDULE

The evaluation is to start up after the committee has been appointed, by the end of April 2020. The committee will draw up a progress plan for the evaluation together with the Research Council. The deadline for submission of the final report to the Research Council is tentatively set for 28 February 2021.

² This is a group of representatives of the administrators of a number of research institutions that have received large grants under the INFRASTRUKTUR initiative. The group carries out informal discussions on various infrastructure-related topics.

8. BUDGET

The estimated resource parameters for the evaluation as currently organised amount to NOK 1.4 million in direct costs (distributed across the period 2020–2021):

- Remuneration to the external evaluation committee: NOK 600 000.

- Remuneration to the secretary: NOK 200 000.

- Committee meetings (travel and accommodation): NOK 300 000.

- Translation/copy editing/layout: NOK 150 000.

- Unforeseen/additional expenses: NOK 150 000, for example:
 - meetings not at Research Council offices;

 - additional meetings with scientific communities;

 - collection of unplanned data requested by the committee, additional review meetings, etc.

Personnel resources are estimated at 1.5 person-years, distributed across the period 2019–2021. Personnel resources primarily comprise two advisors from the Research Council Department for Research Infrastructure and one executive officer from the same department with additional contributions from other internal resources (advisory services from the evaluation group and INFRASTRUKTUR group, legal assistance, communication activities and other).

Expenses relating to the evaluation are to be covered under the agency budget.

2. Material used in the evaluation

The Portfolio report – A RCN produced report covering the initiative including a list of all RIs supported. Figure 3 is taken directly from this report and table 1 is partly. Excel-sheets with more detailed information on each call and the decided grants – table 1 has been updated with information from the sheet and table 2 and fig 1 builds on this information.

Oral presentation by RCN during video-meetings, often supplemented by written presentations in RCN Teams.

Questionnaire to institutions (41 answers, several host RPOs answered at the faculty level rather than at the university level)

Fact sheets and self-evaluations from RIs (93 of 96 gave both fact sheets and self-evaluation)

User surveys (60 of 63 with some form of users sent in their answers)

INFRASTRUKTUR annual reports (in Norwegian)

Long -Term plans Research and Higher Education (2015-2024 and 2019-2028)

National strategy for research infrastructure (2008-2017, 2012-2017 and 2018-20259)

Norwegian Roadmap for Research Infrastructure (2010, 2016, 2018 and 2020)

RCN policy on open access to research (2017)

Evaluation of UNINETT Sigma 2 (2019)

E-infra 2030 recommendations for updating the national e-infrastructure strategy.

UiO Veikart (2020, in Norwegian)

3. Interviewed institutions and RIs

THE FOLLOWING SIX INSTITUTIONS WERE INTERVIEWED:

Norce AS	University of Bergen
NTNU: Norwegian University of Science and Technology	University of Oslo
Sintef AS	University of Tromsø - UiT The Arctic University of Norway

THE FOLLOWING 24 RIS WERE INTERVIEWED:

ACCESS Life Course database	OsloMet-Oslo Metropolitan University	Oslo
Biobank Norway	NTNU	Trondheim
CLARINO	University of Bergen	Bergen
Digital corpus	The Norwegian Academy of Science and Letters	Oslo
EISCAT_3D	UiT The Arctic university of Norway	Tromsø
ELIXIR Norway	University of Bergen	Bergen
Histreg	UiT The Arctic university of Norway	Tromsø
ICOS-OTC	NORCE Norwegian Research Centre AS	Bergen
MANULAB	NTNU	Trondheim
Norwegian Marine Data Centre	Institute of Marine Research	Bergen
MARINTEK	SINTEF Ocean AS	Trondheim
National Microdata Platform	Statistics Norway	Oslo
The fourMs lab	University of Oslo	Oslo
NORBRAIN	NTNU	Trondheim
NorCRIN	St. Olavs hospital	Trondheim
NorFAB	NTNU	Trondheim
Norseq	Oslo University Hospital	Oslo
OpenData	NSD - Norwegian Centre for Research Data	Bergen
Openlab	NORCE Norwegian Research Centre AS	Bergen
RECX	University of Oslo	Oslo
SIOS InfraNOR	Sios Svalbard AS	Longyearbyen
SI-Solar	SINTEF AS	Trondheim
Smartgrid	NTNU	Trondheim
Sigma2	Uninett Sigma2 AS	Trondheim

4. General questions for the interviews

A set of general questions for the interviews were used to plan the interviews although not all were used in every interview.

1. UNIVERSITY/INSTITUTE MANAGERMENTS

Impact of the INFRASTRUKTUR initiative for science and society?

- In your view, what has been the major impact of the INFRASTRUKTUR initiative for science and society and how has this developed in last 10 years?
- Does the INFRASTRUKTUR initiative efficiently contribute to potential research at the international forefront?
- Do you see the INFRASTRUKTUR initiative to have a primary role to fund new infrastructures or upgrades of existing ones? Is the current balance right?

Strategic planning

- What is the role and importance of the INFRASTRUKTUR funding for the University's/Institute's strategic development of advanced RI?
 - Does the INFRASTRUKTUR initiative support you in strategic planning for long term (10-year horizon) research activities/priorities? If so, in what way? Examples? If not, explain why not.
 - Has the INFRASTRUKTUR initiative had any effect on your own investments in RI or advanced equipment?
- Internal process to apply to the INFRASTRUKTUR initiative.
 - Do you have a systematic internal process or prioritization for strategic planning of RI? How does it work?
 - How do you ensure close engagement with end users for planning, setting priorities and making investments in RIs?
- Collaboration
 - Has the INFRASTRUKTUR initiative changed the way you interact and work with partner institutions at national or international level? Examples?

Managing and operating a RI

- Has the INFRASTRUKTUR initiative had any impact on the managing and operating of your research infrastructures? If yes, how?
 - Human resources (recruiting, training, careers etc.)
 - Access policies of RIs e.g. fees and IPR
 - Support provided for the users such as remote use or user hotels.
- Funding
 - What is your strategy for co-funding investments? Operations?
 - How do you fulfil the commitments on operations after the INFRASTRUKTUR investments has been concluded?

Data management

- Are you required by RCN to deal with data management and open access? Is there support and guidelines for it?
- How do you handle the data management issues?
- How do you ensure the development of interoperability of data and open access to data? Is the responsibility clear for storing/archiving/ availability of data? How is it financed and supported?

2. RI MANAGEMENT + USERS

Impact of the INFRASTRUKTUR initiative

- In your view, what has been the major impact of the INFRASTRUKTUR initiative for science and society and how has this developed in last 10 years?
- Does the INFRASTRUKTUR initiative contribute to potential research at the international forefront? Can researchers make their voice heard? Do the grants allow you build world-class RI?
- Does the initiative support a transparent and effective process for making applications, selecting grantees and grant management?
- Do you see the INFRASTRUKTUR initiative to have a primary role to fund new infrastructures or upgrades of existing ones? Is the current balance right?

Strategic planning

- Does the INFRASTRUKTUR initiative support you in strategic planning for long term (10 years horizon) research activities/priorities. If so, in what way? Examples? If not, do have any clear view on what type of support that is needed?
- What is the role and importance of the INFRASTRUKTUR funding for the development of advanced RI? Do you have a systematic internal process for development of your RI? How does it work? How do you treat competition versus collaboration when it comes to building a RI?
- Has the INFRASTRUKTUR initiative changed the way you interact and work with partner institutions at national or international level? Does it have a structuring effect? Examples? Do you interact in a systematic way with other RIs? Do you make common priorities?
- How do you ensure close engagement with end users for planning, setting priorities and making investments in RIs? How do you know that they get access to the right methods and services for high quality research? Do you reach out to potential users as well? Would you characterize your RI as user-driven?

Data management

- Are you required by RCN to deal with data management and open access? Is there support and guidelines for it?
- How do you handle the data management issues? Is there a clear division of responsibility between your host organization and your RI on these issues?
- How do you ensure the development of interoperability of data and open access to data? Is the responsibility clear for storing/archiving/ availability of data? How is it financed and supported?

Managing and operating a RI

- Is there a clear division of responsibilities between the RI and the host organization? Does the RI management have a clear mandate? Is there a clear framework for you to follow?
- What kind of timeframes for funding are you working with? How do you ensure that commitments for funding are fulfilled?
- What is your strategy for co-funding investments? Operations?
- Human resources. How do you train personnel and recruit right persons? Do you have career planning for RI personnel? How do you interact with your host organization in these matters?
- Do your RIs serve a significant national purpose with open access to researchers from other universities? What is your goal and strategy? How do you define services offered to the user and how do you communicate these? What are your policies regarding user access and user fees (internal, external, open/proprietary)? Is there a clear process for selection of users if needed?
- Are there any limitations/diverse conditions for researchers from other universities, institutes, or industry in terms of priorities, scheduling, costs etc.
- Do your RIs generally serve a research group or a broad community (university or national/international)? Are there RI user hotels? (Driven by a user group with high internal interest, but with open services to other researchers (fee or cooperation)).
- How do you handle IPR in connection with the RI?
- How do you threat potential conflicts between policies from user communities and host/governmental policies?
- How do you fulfil the commitments on operations after the investments has been concluded? Is there a mix of funding streams and if user fees are used how are the fees set?
- How do you threat potential conflicts between policies from user communities and host/governmental policies?

5. Questionnaire to institutions

The Research Council of Norway

Evaluation of the INFRASTRUKTUR scheme

Host institution evaluation assessment

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(Name of institution)

Please return the completed assessment directly to Herman Farbrot, The Research Council of Norway (hf@rcn.no) as an attachment to an E-mail

Deadline 10 June 2020

Content

Background

The National Financing Initiative for Research Infrastructure ([INFRASTRUKTUR](#)) was established as a funding instrument in 2009. Its overall objective is to ensure that the Norwegian research community and trade and industry have access to relevant, up-to-date infrastructure that facilitates high-quality research for an innovative, sustainable society and that helps to address the knowledge challenges facing society.

The INFRASTRUKTUR scheme allocates funding to projects with a cost framework of 2 to 200 million NOK from the Research Council. Support is not provided under this initiative for basic equipment that several different research institutions are expected to have or for infrastructure that costs less than 2 million NOK. Decisions regarding investments that exceed 200 million NOK or international research cooperation involving major, long-term commitments in the form of investments and membership dues (e.g. [ESFRI](#)) are taken at the ministerial level based on advice from the Research Council.

The answers to the questions below regarding research infrastructures should be based on infrastructures funded by INFRASTRUKTUR that is either hosted by your institution or where your institution is a formal collaboration partner.

Institutions that are hosting and/or are partner in several research infrastructures funded by INFRASTRUKTUR may experience that it is challenging to give common answers for all infrastructures. In such cases it is helpful if you include information about which infrastructures your answers are relevant for.

Questions

1. *Describe the importance of the INFRASTRUKTUR scheme in meeting your institution's research infrastructure needs.*

Write here...

2. *How does your institution work strategically with research infrastructures? Does your institution have a strategy for research infrastructures? If yes, please provide a linkage to the strategy, attach the strategy as an appendix or make a brief description of it.*

Write here...

3. *How do you prioritize between proposals for INFRASTRUKTURs' calls for proposals?*

Write here...

4. *From your point of view, who are the main beneficiaries of the funded infrastructures (e.g. researchers at your institution, other researchers in Norway, international researchers, industry, public sector or others)?*

Write here...

5. *To what extent does your institution invest in other research infrastructures in areas where relevant infrastructures already exist under the INFRASTRUKTUR scheme? What are the reasons and benefits for doing this?*

Write here...

6. *Describe to what extent the research infrastructures funded under the INFRASTRUKTUR scheme help to:*
- *raise the scientific quality of research in your institution (e.g. enhanced competitiveness for users in various calls for proposals, examples of ground-breaking research).*
 - *increase national and international cooperation and collaboration.*

Write here...

7. *How do you experience cooperation and collaboration between national research infrastructures hosted by different institutions? Please provide examples and explain the reasoning for your views. The RCN appreciates suggestions on how we can contribute to improvements.*

Write here...

8. *Describe pros and cons associated with hosting research infrastructure(s) in operation (where the establishment or upgrade of the infrastructure is funded by INFRASTRUKTUR). If relevant describe pros and cons associated with hosting a Norwegian node of an ESFRI project.*

Write here...

9. *Describe in what way your institution supports the infrastructures, funded by INFRASTRUKTUR, that your employees lead or take part in. If possible, please provide examples.*

Write here...

10. *In which ways do the infrastructures contribute towards reliable, long-term storage and archiving of research data, as well as increase the accessibility and reuse of research data in keeping with the [FAIR principles](#)? Please include information about the institutions data policy.*

Write here...

11. To what extent and by which ways do the infrastructures support research addressing societal challenges?

Write here...

12. How do you experience the allocation mechanisms under the INFRASTRUKTUR scheme (frequency of funding announcements, application procedures, use of roadmaps, allocation between different areas etc.)? How may the INFRASTRUKTUR scheme be improved?

Write here...

13. Are there any other topics you want to report on?

Write here....

6. Template for self-evaluation for operational RIs

The Research Council of Norway

Evaluation of the INFRASTRUKTUR scheme

Infrastructure Self-evaluation

.....

(Name of infrastructure)

.....

(Project number(s))

Please return the completed assessment directly to Herman Farbrot, The Research Council of Norway (hf@rcn.no) as an attachment to an E-mail

Deadline 10 June 2020

This document is to be filled out by infrastructures that are in operation.

The answers are to be prepared by the project manager in cooperation with partners.

1. Impacts on research and the research system

Enabling scientific excellence

Describe the role of the infrastructure in meeting the research communities' needs for infrastructure and services (both internal and external users).

Write here...

Describe the importance of the infrastructure for relevant fields of research. To what extent does the infrastructure help to raise the scientific quality of Norwegian research? If possible, please include some highlights from research that has made use of the infrastructure.

Write here...

Education and training

Describe how the infrastructure is contributing to education and training.

Write here...

Enhancing national and international collaboration

Describe how the infrastructure helps to strengthen national and/or international research collaboration.

Write here...

Describe to what extent the infrastructure cooperates with other relevant national and international research infrastructures.

Write here...

For ESFRI infrastructures:

Describe how you experience the added value of being part of a European infrastructure.

Write here...

Optimising data use

To what extent are you familiar with the FAIR-Principles?

Write here...

What measures are being made to ensure that data from your infrastructure is Findable, Accessible, Interoperable and Reusable?

Write here...

How do you ensure long-term storage of data? If you have a policy in place, include information about this.

Write here...

2. Benefits to society

Describe to what extent the infrastructure supports research addressing societal challenges. If possible, include some relevant highlights from research that has made use of the infrastructure.

Write here...

Describe to what extent the infrastructure has contributed to enhancing value creation and/or innovation capacity in the private and/or public sector.

Write here...

What has been done to attract new partners and/or users?

Write here...

3. Organisation of the infrastructure

Describe the organisation of the infrastructure.

Write here...

Funding

Describe the financial model for the operational phase of the infrastructure.

Write here...

Discuss concerns regarding financial matters. Note that budgets are already submitted to the RCN.

Write here...

Would the infrastructure have been operative without funding from the INFRASTRUKTUR scheme? If yes, what would the capacity of the infrastructure have been compared to the current status? What would have been the alternative funding sources?

Write here...

Support from the host institution

Describe in what way your institution supports the infrastructure that you are leading.

Write here...

Long term relevance

How do you work to make sure that the infrastructure will continue to offer the best possible solutions for research in the long term?

Write here...

4. The INFRASTRUKTUR scheme and the RCN

How will you rate your experience with the RCN in the following processes?

A. Information about the INFRASTRUKTUR scheme and its calls for proposals

- Very satisfied
- Satisfied
- Neither satisfied nor dissatisfied
- Dissatisfied
- Very dissatisfied
- Not applicable

B. The application and decision-making processes

- Very satisfied
- Satisfied
- Neither satisfied nor dissatisfied
- Dissatisfied
- Very dissatisfied
- Not applicable

C. The contract phase

- Very satisfied
- Satisfied
- Neither satisfied nor dissatisfied
- Dissatisfied
- Very dissatisfied
- Not applicable

D. The follow-up and reporting

- Very satisfied
- Satisfied
- Neither satisfied nor dissatisfied
- Dissatisfied
- Very dissatisfied
- Not applicable

Do you have any recommendations or comments for the RCN concerning these matters?

How do you experience the allocation mechanisms under the INFRASTRUKTUR scheme (frequency of funding announcements, application procedures, use of roadmaps, allocation between different areas etc.)? How may the INFRASTRUKTUR scheme be improved?

Write here...

Infrastructure of national interest

Describe, from your point of view, how your infrastructure is of national importance.

Write here...

5. Other comments

Write here...

7. Request for user survey (in Norwegian)



Til prosjektledere for forskningsinfrastrukturer

Vår saksbehandler/tlf.
Herman Farbrot/90919304

Vår ref.
20/35

Oslo,
23.03.2020

Deres ref.

Forespørsel om gjennomføring av brukerundersøkelse

Dette er en forespørsel som går til alle forskningsinfrastrukturer som har mottatt finansiering gjennom INFRASTRUKTUR-ordningen og som har kommet helt eller delvis i driftsfase.

Som vi skrev i en e-post til dere den 6. mars, vil Forskningsrådet be om at det gjennomføres en brukerundersøkelse. Dette brevet er å anse som en bestilling. Vi er klar over at det er spesielle tider med koronasituasjonen, men vi håper likevel at dette lar seg gjennomføre.

Forskningsrådet er i gang med å evaluere Nasjonal satsning for forskningsinfrastruktur (INFRASTRUKTUR). Vi ønsker å evaluere samfunnsnyttien, effekten og organiseringen av ordningen. Det vil ikke gjøres en evaluering av enkelte infrastrukturer, men for å kunne vurdere ordningen som helhet trenger vi informasjon og hjelp fra dere. Mer informasjon om evalueringen finnes her.

Vi ønsker at alle som mottar denne forespørselen gjennomfører en undersøkelse av brukertilfredshet og av hvilken betydning forskningsinfrastrukturen har for brukeren (brukerundersøkelse). De fleste av dere vil i artikkel 8 i kontrakten med Forskningsrådet, se at dette er noe vi kan be dere om. For de av dere som ikke har dette spesifisert i kontrakten eller har avsluttet kontrakten med oss, ber vi dere likevel om å vurdere muligheten av å gjennomføre en slik undersøkelse. Vi tror det vil være nyttig for både dere og oss!

Dersom dere nylig har gjennomført en brukerundersøkelse eller av andre grunner ser at det er utfordrende å gjennomføre dette, ber vi dere om å kontakte oss.

Spesifisering av brukerundersøkelsen

For at brukerundersøkelsene skal bli sammenlignbare, har vi i vedlegg til dette brevet laget en oversikt over hva en slik brukerundersøkelse skal kunne gi svar på. Spørsmålene må tilpasses til den enkelte infrastruktur, men vi ber dere benytte dette som et utgangspunkt. Dere står fritt til å utvide brukerundersøkelsen med egne spørsmål.

Norges forskningsråd/
The Research Council of Norway
Drammensveien 288
Postboks 564
NO-1327 Lysaker

Telefon +47 22 03 70 00
post@forskningsradet.no
www.forskningsradet.no
Org.nr. 970141669

All post og e-post som inngår i saksbehandlingen, bes adressert til Norges forskningsråd og ikke til enkeltpersoner.

Kindly address all mail and e-mail to the Research Council of Norway, not to individual staff.

Det varierer noe mellom infrastrukturene hvor lenge de har vært i drift. Brukerundersøkelsen bør maksimalt dekke de tre siste årene.

Finansieringen fra Forskningsrådet kan inngå som en del av en større infrastruktur. Dette kan medføre at prosjektnavnet vi opererer med i Forskningsrådet ikke samsvarer med det navnet brukeren kjenner for infrastrukturen. Det viktigste for oss er at brukeren vet hva det spørres om. Vi trenger i slike tilfeller å motta et estimat fra dere på hvor stort bidraget fra Forskningsrådet utgjør av den totale infrastrukturen.

Leveranse til Forskningsrådet

Det er dere som kjenner infrastrukturene best og vil være de beste til å oppsummere resultatene av brukerundersøkelsen. Vi ber dere om å lage en lettfattelig rapport på engelsk der dere benytter tabeller, diagrammer mv. for å fremstille resultatene. I tillegg ønsker vi at dere lager en kort skriftlig vurdering. Forskningsrådet vil dersom det er behov etterspørre mer detaljert informasjon. Se vedlegg for mer detaljert informasjon.

Denne forespørselen er i tid litt overlappende med søknadsfristen for Forskerprosjekter (utsatt fra 6. til 20. mai) og obligatorisk skisse som grunnlag for søknad om forskningsinfrastruktur med frist 27. mai. **Vi ber dere levere besvarelsen på brukerundersøkelsen så raskt som mulig og senest innen 1.juni 2020.**

Ta gjerne kontakt med oss i prosessen. Vi er her for å bistå.

Med vennlig hilsen
Norges forskningsråd

Solveig Flock
Avdelingsdirektør
Forskningsinfrastruktur

Herman Farbrot
Seniorrådgiver
Forskningsinfrastruktur

Vedlegg: Spesifisering av brukerundersøkelsen

Vedlegg

Spesifisering av brukerundersøkelsen

Brukerundersøkelsene vil være viktig som grunnlag for evalueringskomiteen, men også for infrastrukturene selv. Det er mange infrastrukturer som skal sende ut brukerundersøkelser. For at vi skal kunne oppsummere resultater og sammenligne dem er det viktig at brukerne spørres om tilnærmet de samme tema og at tilsvarende svarkategorier benyttes. Infrastrukturene må selv tilpasse spørsmålene slik at de blir relevante for dem. Det er selvfølgelig mulig med tilleggsspørsmål i undersøkelsen etter eget ønske.

Hvem skal spørres? I utgangspunktet tenker vi at det er enkeltpersoner som skal besvare brukerundersøkelsen, men vi vet at det kan være hensiktsmessig for noen av infrastrukturene å forespørre prosjekter. Dersom dette er tilfelle, bør antall brukere besvarelsen gjelder for spesifiseres.

Språk: Det er opp til dere å velge om brukerundersøkelsen gjennomføres på norsk eller engelsk. Velg det som er best for brukergruppen. Vær oppmerksom på at Forskningsrådet ønsker å motta oppsummeringen av undersøkelsen på engelsk slik at den skal være forståelig for evalueringskomiteen.

Tidsperiode for brukerundersøkelsen: Dersom det har det vært jevn bruk av infrastrukturen siste tre årene, kan det legges opp til at det gjennomføres en brukerundersøkelse for siste år, altså 2019. Dersom bruken varierer mellom år, bør det gjennomføres en brukerundersøkelse for de tre siste årene (2017-2019).

Elektroniske verktøy: Vi går ut fra at de fleste institusjoner har tilgang til elektroniske verktøy slik som Windows Forms, Questback eller SurveyXact. Vår anbefaling er at dere kontakter kommunikasjon ved egen institusjon for hjelp.

Under er punkter som vi ønsker at brukerundersøkelsen skal gi svar på.

1. Hvem svarer brukeren for?

For enkelte infrastrukturer kan det være hensiktsmessig at det ikke er enkeltbrukere som svarer, f.eks. en svarer for flere i et prosjekt. For å kunne si noe om svarprosenten totalt sett for infrastrukturen kan det være hensiktsmessig å hente inn informasjon om dette.

Kategorier

1. Seg selv
2. På vegne av en gruppe (f. eks. prosjekt, institusjon)

Hvis 2, angi antall deltagere i gruppen

2. Hvem er brukeren?

Bør vurderes om denne er relevant dersom svarene kommer fra en gruppe.

Type stilling

Kategorier

- Vitenskapelig personell

- PostDoc
- PhD/Master studenter
- Teknisk personell
- Annet, spesifiser
- Ikke relevant

Institusjonell tilhørighet

Kategorier

- UoH-sektor
- Sykehus/helseforetak
- Instituttsektor
- Næringsliv
- Offentlig sektor
- Øvrige, spesifiser
- Ikke relevant

Institusjonens nasjonale tilhørighet

Kategorier

- Norge
- Europa
- Andre områder (spesifiser)

3. Hvilken del av infrastrukturen (node) og/eller tjenester brukeren benytter

Dette defineres av infrastrukturene selv avhengig av hva som er hensiktsmessig.

4. Hvordan brukeren fikk kjennskap til infrastrukturen

Kategorier:

- Internett/Nettsider
- Fra en kollega
- Gjennom en presentasjon på møte/konferanse
- Gjennom vitenskapelig publikasjon
- Annet, spesifiser

5. Omfang av bruk

Hensikten her er å få informasjon om hvor hyppig brukeren benytter seg av infrastrukturen eller tjenestene den leverer. Det kan variere med type infrastruktur hvordan spørsmålet bør vinkles og hva som bør ligge i kategoriene sjelden, middels og mye. Hver infrastruktur må selv definere inndelingen i de foreslåtte kategoriene.

Dersom brukerundersøkelsen legges opp over flere år, bør det vurderes om det er hensiktsmessig å legge inn hvilken tidsperiode det spørres om og dele opp bruken pr år.

Kategorier:

- Sjelden (< a)
- Middels (a-b)
- Mye (>b)

6. Brukertilfredshet

Spørsmålene må tilpasses hvilken type infrastruktur det er snakk om. Ikke alle spørsmålene er relevante for alle infrastrukturer.

Hvordan brukeren opplever responstiden på tjenester

Kategorier:

- Svært fornøyd
- Fornøyd
- Verken - eller
- Lite fornøyd
- Svært misfornøyd
- Ikke relevant

Hvordan brukeren opplever tilgjengeligheten av infrastrukturen

Kategorier:

- Svært fornøyd
- Fornøyd
- Verken - eller
- Lite fornøyd
- Svært misfornøyd
- Ikke relevant

Hvordan brukeren opplever service knyttet til bruk av infrastrukturen

Kategorier:

- Svært fornøyd
- Fornøyd
- Verken - eller
- Lite fornøyd
- Svært misfornøyd
- Ikke relevant

Leverer infrastrukturen de tjenester som brukerne etterspør?

Kategorier:

- Ja
- Delvis
- Nei
- Vet ikke
- Ikke relevant

Hvordan brukeren opplever kostnadene knyttet til bruk av infrastrukturen

Kategorier:

- Mye for pengene
- Akseptabelt
- For kostbart
- Ikke relevant

Hvordan brukeren opplever kostnadene knyttet til kjøp av tjenester

Kategorier:

- Mye for pengene
- Akseptabelt
- For kostbart
- Ikke relevant

Benytter brukeren også tilsvarende infrastrukturer og/eller tjenester andre steder?

Kategorier:

- Ja
- Nei
- Hvis ja, hvilke og hvorfor

7. Innspill på forbedringer

Dette vil være av nytte for infrastrukturene selv for å forbedre tjenestene mv.

Fri tekst

8. Andre kommentarer

Fri tekst

Rapportering til Forskningsrådet

Forskningsrådet ønsker å motta en kortfattet rapport fra infrastrukturene som oppsummerer tilbakemeldingene fra brukerne. Denne rapporten skal skrives på engelsk slik at evalueringskomiteen skal kunne nyttiggjøre seg av informasjonen. Forskningsrådet vil spørre om mer detaljert informasjon dersom det er behov for det.

Under er punkter som rapporten skal inkludere.

- **Navn på infrastrukturen brukerundersøkelsen er gjennomført for**
Dersom finansieringen fra Forskningsrådet som en delmengde av en større infrastruktur, ønsker vi informasjon om følgende:
 - Prosjekt(er) finansiert over INFRASTRUKTUR-ordningen som inngår
 - Andelen av infrastrukturen som er finansiert av INFRASTRUKTUR-ordningen
- **Tidsrommet brukerundersøkelsen dekker (år)**
- **Hvem svarer brukerne for – personlig eller i hovedsak på grupper (punkt 1 i spesifiseringen av brukerundersøkelsen over)**
- **Antall brukere forespurt og antall svar (tall)**
- **Fordeling av brukere på organisasjoner, nasjonal tilhørighet og stillingskategorier (tall og prosentvis fordeling; punkt 2)**
- **Fordeling av brukere på noder der dette er definert (tall og prosentvis fordeling; punkt 3)**
- **Fordeling over hvor brukeren fikk kjennskap til infrastrukturen (tall og prosentvis fordeling; punkt 4)**
- **Omfang av bruk (søylediagram og informasjon om hvordan kategoriene er inndelt; punkt 5)**
- **Brukertilfredshet fremstilles i diagramform fordelt på svarkategoriene (punkt 6)**
- **Sammendrag av tilbakemeldinger på forbedringer (punkt 7)**
- **Sammendrag av andre tilbakemeldinger (punkt 8)**
- **Informasjon som er nødvendig for å forstå resultatene**



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