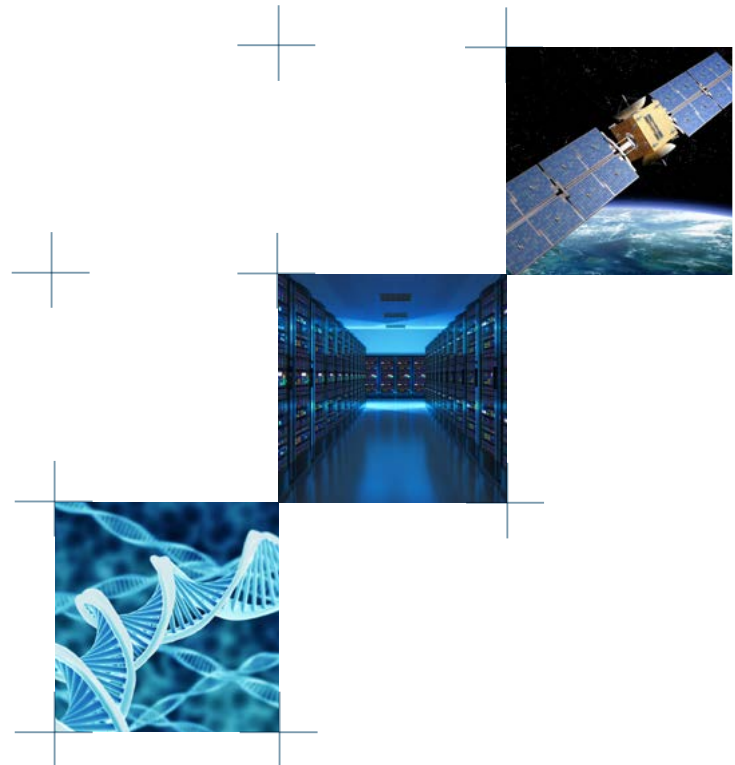




Tools for Research

National strategy for research infrastructure 2018–2025

National Financing Initiative for Research Infrastructure (INFRASTRUKTUR)



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National strategy for research infrastructure 2018-2025

National Financing Initiative for Research Infrastructure (INFRASTRUCTURE)

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Preface

The Government's and Research Council's National Financing Initiative for Research Infrastructure (INFRASTRUKTUR) has thus far provided funding for roughly 100 research infrastructures. These infrastructures will serve a wide range of research groups, many of which are international leaders in their field and contribute to Norwegian innovation in key areas of society – such as environment-friendly energy, technology for future Norwegian industrial products, and improved health. Access to top-calibre research infrastructure promotes quality in Norwegian research and cooperation with the best international research groups, as well as inspires students to pursue careers in research.

Most infrastructures are established as collaborative projects involving multiple research institutions and many are part of a larger-scale European collaborative effort. Some of the infrastructures are databases, for compiling data on everything from medieval texts to climate development to genetic information on humans, animals and plants. Other infrastructures comprise advanced scientific equipment varying in size from small-scale equipment components to large-scale laboratory facilities. Investments in electronic infrastructure (e-infrastructure) for high-performance computing and storage of vast amounts of data are essential to carrying out research accurately and efficiently in a number of disciplines.

Many of the recommendations set out by the Research Council in the first version of this strategy have been realised under the National Financing Initiative for Research Infrastructure. The Research Council has implemented the strategy using funding award processes in which a competition based on scientific merit is combined with an overall assessment of strategic importance.

The national strategy for research infrastructure, *Tools for Research*, is to be revised on a regular basis in response to changes in national priorities and the needs specified by the research institutions. This 2018 version of *Tools for Research* is the result of such an update process. This document sets out the guidelines for funding of research infrastructure by the Research Council and provides recommendations to the ministries and the R&D institutions. This version of *Tools for Research* devotes more attention to data infrastructures as there is an increasing need for such infrastructures in most fields and there are challenges involved in ensuring their sustainable operation. Furthermore, the strategy's objectives have been updated in keeping with the Research Council's main strategy, *Research for Innovation and Sustainability 2015–2020*. Otherwise, this updated strategy is by and large a continuation of previously defined priority areas and principles for distribution of tasks between the stakeholders and the award of Research Council allocations.

The need to establish new and upgrade existing research infrastructure, which has been highlighted in the response to the Research Council's five infrastructure-related funding announcements as well as in relevant strategy documents, is presented by individual area strategies in the Norwegian Roadmap for Research Infrastructure. The roadmap was initially published in 2010 and has since been updated every other year. The area strategies given there describe the strategic basis for the Research Council's thinking and priority-setting with regard to research infrastructure. The roadmap identifies major research infrastructures of national importance, including those granted funding and projects of very high quality that have not yet been funded, and is designed as a guide for allocating agencies such as the ministries. The roadmap supports the recommendations set out in Part 1 to uphold the annual funding level from 2018 in the years ahead. The Research Council will continue to give priority to investments in research infrastructure that promote (1) the highest-quality research, particularly within national priority areas, (2) good national task-sharing, (3) good international task-sharing, (4) infrastructures for accessibility and sharing of data, and (5) a balance between new establishment and renewal of outdated research infrastructure.

John-Arne Røttingen
Chief Executive, The Research Council of Norway

1 Objectives

This strategy seeks to achieve the following primary objective:

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 (the Research Council's main strategy, *Research for Innovation and Sustainability, 2015–2020*).¹

2 Background

The past decade has seen major changes in the funding of research infrastructure of national importance. One of the objectives of the Norwegian Government's *Long-term plan for research and higher education 2015–2024*² is to provide the best researchers and students with world-class research infrastructure and to strengthen funding of infrastructure based on strategic assessments and priorities. The Government has subsequently implemented an ambitious and predictable escalation plan of increases in the annual allocations to the National Financing Initiative for Research Infrastructure (INFRASTRUKTUR), which per 2018 has an annual budget of nearly NOK 740 million.

The National Financing Initiative for Research Infrastructure was launched in 2009 as part of following up the white paper on research³ and the Research Council's national strategy for research infrastructure, *Tools for Research*.⁴ The National Financing Initiative for Research Infrastructure is funded by the Ministry of Education and Research to contribute to a well-functioning research system that supplies high-quality research, develops knowledge for dealing with key challenges to society and the business sector, fosters dynamic interaction nationally and internationally, and creates a framework for learning, application and innovation.⁵ Funding of high-quality research infrastructure is also intended to enhance internationalisation and recruitment.

The National Financing Initiative for Research Infrastructure helps to provide the Norwegian research community with access to infrastructure that is necessary at any given time for:

- carrying out research of high international quality;
- achieving a high degree of institutional cooperation and national task distribution;
- expanding international cooperation;
- ensuring open access for the use and reuse of research data.

¹ Main strategy for the Research Council of Norway, *Research for Innovation and Sustainability (2015–2020)*.

² Meld. St. 7 (2014–2015) *Long-term plan for research and higher education 2015–2024*, white paper from the Ministry of Education and Research

³ Report No. 30 (2008–2009) to the Storting, *Climate for Research*

⁴ *Tools for Research – national strategy for research infrastructure* (Research Council, 2008).

⁵ *Research for Innovation and Sustainability, main strategy for the Research Council of Norway 2015–2020*.

The international FAIR Guiding Principles for scientific data management and stewardship

The international FAIR Principles have been formulated as a set of guidelines for the reuse of research data. The acronym FAIR stands for findable, accessible, interoperable and reusable. Research data must be of quality that makes them accessible, findable and reusable. The concept interoperable entails that both data and metadata must be machine-readable and that a consistent terminology is used.

Source: [Wilkinson, Mark D. et al. \(2016\) "The FAIR Guiding Principles for scientific data management and stewardship". Scientific Data.3](#)

See also: <https://www.force11.org/group/fairgroup/fairprinciples>

Knowledge needs

Research helps to develop knowledge for dealing with key challenges to society and the business sector.⁶ Access to the latest tools will enable the research community to comply with society's need for increased sustainability and more innovation and restructuring through efficient, high-quality research activities. Up-to-date infrastructure also creates a better foundation for researchers from various disciplines to use the infrastructure and collaborate on interdisciplinary projects. Increasingly, the competitiveness of the business sector is tied to expertise and technology developed in close cooperation with internationally leading academic environments with access to modern research facilities. Similarly, the development of services in the Norwegian public sector is contingent on high-quality research.

Attractive and efficient

In research as in other endeavours, proper tools are essential to achieving targeted, efficient operations. Modern, up-to-date research infrastructure promotes high quality in Norwegian research, facilitates cooperation with the best international research groups, and inspires talented students to pursue careers in research. Top-notch research infrastructure, combined with outstanding researchers, is essential to the successful implementation of innovation projects in the industrial and public sectors. This may be a critical factor when domestic and international companies are considering whether to implement their research activities in Norway.

2.1 Research infrastructure in Europe and the rest of the world

European research policy-makers at both the national and pan-European level are well aware of the need for updated research infrastructure. The Norwegian Government's *Long-term plan for research and higher education*⁷ stresses the importance of Norway's participation in European cooperation on research infrastructure, both for attracting top international researchers and for ensuring that Norwegian scientists have access to the best research infrastructures available in Europe. Norway takes part in over 30 European collaborations on research infrastructure and pays annual membership fees to use these facilities. While this is vitally important for Norwegian research activities, there is a need for ongoing cost-benefit analyses of memberships of new, large-scale international infrastructures and of the value of continuing current memberships.

⁶ Research for Innovation and Sustainability (2015–2020), main strategy for Research Council of Norway.

⁷ Meld. St. 7 (2014–2015) Long-term plan for research and higher education 2015–2024, white paper from the Ministry of Education and Research

ESFRI Roadmap

The European Strategy Forum for Research Infrastructures (ESFRI) promotes pan-European policy development and cooperation on investment in and operation of research infrastructures. ESFRI serves as a meeting place where national representatives discuss relevant infrastructure-related issues. The forum also draws up the ESFRI Roadmap, which identifies needs for updating or establishing new pan-European research infrastructures in most research areas. The European research infrastructures on the ESFRI Roadmap enable research that addresses major societal challenges in areas such as health, climate, the environment, oceans, food and energy. ESFRI incorporates landscape analyses into its roadmap⁸ to describe the national and international research infrastructures open to European researchers and industrial actors.

Single-site or distributed research infrastructure

A research infrastructure can either be *located* at a single site or *distributed* across countries that have complementary nodes within a common infrastructure. An infrastructure located at one site typically has relatively high investment and operating costs, which is why several countries work together on funding that infrastructure. A distributed research infrastructure, as defined by ESFRI, is organised as a separate legal entity jointly owned and managed by participating countries, and with nationally owned nodes. The national nodes are required to make some of their capacity available to users from the other participating countries. It is important that the national nodes establish a long-term business model that covers operating costs. As a rule, investment and operating costs for the joint legal entity are covered by the participating countries' membership fees. A majority of the research infrastructures on the ESFRI Roadmap are distributed.

Principles of ESFRI membership

The Ministry of Education and Research has asked the Research Council to follow up Norwegian participation in ESFRI. This involves, among other things, drawing up an analysis document for decision-making and put forth recommendations regarding Norwegian participation in individual research infrastructures on the ESFRI Roadmap. In collaboration with the Ministry, the Research Council has set out principles for: establishing, continuing and withdrawing memberships; how the institutions and the Research Council are to deal with membership funding; and Norwegian representation in the infrastructures' governing bodies (see the fact box). The Research Council bases its recommendations on assessment of grant applications under the National Financing Initiative for Research Infrastructure.

⁸ ESFRI Roadmap

Norwegian participation in international research infrastructure

Establishing membership

- It is typically a government ministry that formally applies for Norwegian membership of an international research infrastructure and that may subsequently withdraw Norway from the cooperation.
- Research communities are to submit an application to the Research Council for the establishment of new memberships. The application will be subject to the same review procedure as other grant applications under the National Financing Initiative for Research Infrastructure. This is designed to ensure that funding is awarded to the projects of highest merit and national strategic relevance. The Research Council will assess the long-term financial obligations that membership entails and the extent to which membership will comprise added value for Norwegian research when ranking such applications ahead of other national or international applications.
- After assessing the application, the Research Council will advise the relevant ministry on whether to establish Norwegian membership.

Membership fees

- For single-site infrastructures, operating costs are typically financed through an annual membership fee. The National Financing Initiative for Research Infrastructure may provide funding towards such membership fees. A pledge may only be granted for a specific period, usually five years. Any continued financing must be based on regularly submitted applications under the National Financing Initiative for Research Infrastructure or on evaluations.
- For distributed research infrastructures with one or more Norwegian nodes, the Research Council considers membership fees to be part of the operating costs of the national node(s).

Norwegian representation in governing bodies for projects on the ESFRI Roadmap

- To ensure that memberships are adequately supported in Norwegian research institutions, the institutions should be involved in the management of the Norwegian memberships.
- Where Norway has decided on – or the Research Council has recommended – membership in ESFRI projects still in the planning and implementation phase, the Research Council will as a rule have a role in the project's governing body. The Council may, however, in consultation with the relevant ministry, choose to appoint a resource person from a Norwegian research institution to take the Council's place in the governing body.
- In ESFRI projects that have entered a well-functioning operational phase, the Research Council, in consultation with the relevant ministry, will consider replacing its own representation in the governing body with a resource person from one of the participating Norwegian research institutions.

2.2 Status in Norway, 2018

The National Financing Initiative for Research Infrastructure has issued five calls for proposals in the period 2009–2016. A total of 650 grant applications have been reviewed and roughly 100 infrastructure projects have been granted funding for a total allocation of over NOK 5 billion. Funding decisions have been made after an application review process based on scientific assessments of each infrastructure's impact for the research activities that would utilise it, combined with an overall strategic assessment.

These allocations support the Government's *Long-term plan for research and higher education 2015–2024*.¹⁰ All the investments in infrastructures of national importance facilitate development of world-leading expert communities. Figure 1 shows the investments within each of the Long-term plan's thematic priorities for each of the five calls issued thus far. Several of the infrastructures are highly relevant for more than one area, which is why the sum of the columns for each priority area is higher than the actual total investments.

For all five calls, the total amount of funding sought was far higher than the total amount allocated. This indicates a great need for long-term predictability in the Research Council's allocations for research infrastructure. Many of the equipment facilities comprise technically advanced instruments that become obsolete quickly (after 5–10 years), requiring continual upgrading and renewal. Thus, an increasing proportion of allocations under the National Financing Initiative for Research Infrastructure goes to upgrading and renewal of existing national research infrastructure. At the same time, the strategic review of the various areas on the Norwegian Roadmap for Research Infrastructure and the volume of received grant applications indicates there is still a significant need for investment in an array of entirely new infrastructures.

Table 1: Number of grant applications, total amount sought and amounts allocated under the five INFRASTRUKTUR calls for proposals.

Call for proposals	Number of grant applications	Amount sought* [NOK mill]	Number of applications awarded funding	Amount allocated* [NOK mill]	Percentage, allocated/ sought
2009	250	6500	22	474	8 %
2010	150	4000	18	501	13 %
2012	70	2700	16	505	19 %
2014	88	4500	31	1378	31 %
2016	92	5700	20	1000	18 %

¹⁰ Meld. St. 7 (2014–2015) Long-term plan for research and higher education 2015–2024, white paper from the Ministry of Education and Research

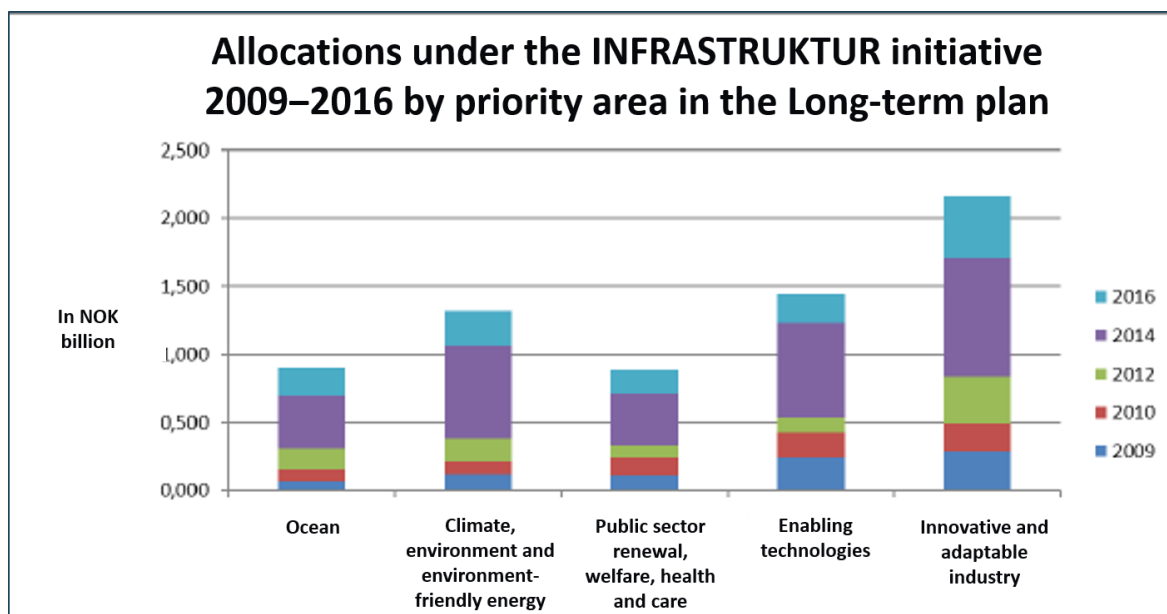


Figure 1. Allocations under the National Financing Initiative for Research Infrastructure within the priority areas set out in the Norwegian Government's Long-term plan for research and higher education 2015–2024. The investment period is typically five years. The columns show amounts allocated for each area under each of the five annual calls.

The Government's *National strategy on access to and sharing of research data* (2017) emphasises that open access to the use and reuse of research data requires specially adapted research infrastructure. In the period 2009–2016, the Research Council invested more than NOK 1 billion in about 20 infrastructures whose entire purpose, or a significant part of it, is data management. This includes both generic and subject-specific data infrastructures, e-infrastructures, scientific databases and collections, and services for method development and data analysis. Applications to the National Financing Initiative for Research Infrastructure indicated that needs for data infrastructure for the management and accessibility of data are increasing in most fields. There are also substantial costs associated with continually developing knowledge-based data infrastructures to meet the needs of researchers and make it possible to use collected data in important subject fields and thematic areas.

The consistently high volume of grant applications under the National Financing Initiative for Research Infrastructure and the high relevance of the applications for Norwegian R&D priority areas show that there is still a large, unmet need for research infrastructure of national importance in Norway.

2.3 Distribution of decision-making responsibility regarding establishment of research infrastructure

The government white paper on research *Climate for Research*¹¹ defines a distribution of decision-making between the R&D institutions, the Research Council and the ministries with regard to the establishment of new research infrastructure.

The R&D institutions

The basic infrastructure at R&D institutions consists of the scientific equipment needed to conduct activities of adequate quality. Investments in and the establishment of such infrastructure should be

¹¹ Report No. 30 (2008–2009) to the Storting, *Climate for Research*

covered by the institutions themselves, and funded through the basic allocation they receive. R&D institutions are considered to be in the best position to assess which basic equipment they need and to ensure that allocation procedures remain simple and efficient.

The Research Council will contribute to the institutions' own investments by allowing *all* grants for R&D projects involving the use of infrastructure procured by the institution itself to be used to cover a relative percentage of the depreciation costs of this infrastructure. Research Council grants may also be used to cover operating costs for the project's use of infrastructure, and towards "project-specific equipment", defined as equipment that is necessary for the execution of the research project and that will not be of any additional use outside the scope of the project.

The Research Council

The Research Council is responsible for taking decisions regarding investment in research infrastructure *of national importance* (see the fact box). Funding channelled via the Research Council is intended to support the development of research areas of national priority and industries of national importance with a significant need for research infrastructure. The Research Council will help to coordinate investments when multiple research communities need a certain type of infrastructure but the costs are so high that cooperation is the best solution. The Research Council assesses grant applications for research infrastructure involving investment costs starting at NOK 2 million and up, and can grant a maximum of NOK 200 million in project funding to individual projects.

The establishment of research infrastructure involving external investments that exceed NOK 200 million is decided at the ministerial or government level. However, the Research Council may assess grant proposals seeking more than NOK 200 million as part of the review process for other grant proposals in order to make its recommendation to the relevant ministries. Institutions or consortia seeking to establish research facilities with investment costs over NOK 200 million are encouraged to contact the Research Council for submission and assessment of such proposals together with other applications. A positive recommendation may be provided for projects that have received high marks in relation to the assessment criteria stipulated by the Research Council. In exceptional cases, the Research Council, in consultation with the Ministry of Education and Research, may allocate funding for the planning phase of a project.

Since the National Financing Initiative for Research Infrastructure primarily targets the *renewal* of Norwegian research infrastructure, the Research Council has a restrictive policy concerning funding *of operating costs* of research infrastructures. Instead, the operating costs of research infrastructure are as far as possible to be covered by the projects that use it. Thus, the Research Council requires applicants seeking funding to establish research infrastructure to include plans for how to achieve sustainable operation of the infrastructure. User fees from the R&D projects using the infrastructure should ideally be an integral part of financing its operation. Expenses related to use of research infrastructure are therefore approved costs in all applications for research funding from the various Research Council programmes and funding schemes.

In special cases, support for operating costs for new or existing research infrastructure of national importance may be provided under the National Financing Initiative for Research Infrastructure. Infrastructures with particularly large operating costs may after a separate assessment process be allocated long-term funding for operation when ongoing projects, host institutions or other funders cannot reasonably be expected to cover the costs. Similar exceptions may apply under other conditions where funding from the user projects or the infrastructure owner institution(s) is clearly impractical.

Research infrastructure of national importance:

- **Infrastructure that is of widespread national interest**
The establishment of the infrastructure must be of major interest to Norway as a whole. The Research Council will incorporate considerations relating to national priorities.
- **Infrastructure that will be available in only one or a few locations in Norway, as a general rule**
The Research Council encourages research institutions with common interests to implement task-sharing when appropriate and work together on grant applications.
- **Infrastructure that lays a foundation for internationally cutting-edge research**
Allocations are intended to support the activities of research groups that are already at the international forefront or demonstrate good potential realistically speaking to achieve that position.
- **Infrastructure that will be made accessible to relevant researchers and industries**
Access must be given to any groups outside the applicant institution that will need to utilise the infrastructure. Grant applications must include plans for user access.

The National Financing Initiative for Research Infrastructure will enable the Research Council to make research data accessible in secure systems and in such a way that they can form the basis for research cooperation both nationally and internationally, as well as ensure Norwegian participation in international data networks. Funding may be sought under the initiative for infrastructure contributing to data management and accessibility to research data, more specifically, for procurement and establishment of equipment and tools for collection of data for research, technical systems for quality assurance and preparation of data and technical systems for archiving data and promoting access for research activities.

The initiative does not provide funding for generation/collection of data, as this is provided by the ministries and their subordinate agencies, as well as under research projects funded by the Research Council and activities funded by the R&D institutions themselves.

Research Council funding for research infrastructure is available for grant applications within all subject fields and thematic areas. The Research Council is to use the grant allocation process to ensure scientific quality, conduct strategic assessments and emphasise national priorities. Specific thematic areas or disciplines may be weighted differently in funding announcements to enable the Research Council to channel investments into areas with high research activity and a significant need for equipment, and to follow up political and strategic guidelines.

The role of the ministries

Decisions regarding international research cooperation involving major, long-term commitments in the form of investments and membership dues are taken at the ministerial level. Funding for national research facilities involving investments that exceed NOK 200 million will also be dealt with at the ministerial or government level, in many cases after consultation with the Research Council. Allocations for such investments should ideally comprise an addition to the permanent budget item for research infrastructure in the national budget.

2.4 Value of national coordination

It is natural that several research institutions collaborate on and use certain types of research infrastructure. A single institution cannot be expected to finance very costly scientific equipment on its own, and it is important that equipment involving such significant investments is utilised effectively by a wider user group. Databases are normally built, developed and used by many research groups. High-performance computing clusters and networks are essential for research activities in almost all subject fields. It is vital that the Research Council assists in coordinating

investments in these and other areas and helps to ensure that the infrastructures are satisfactorily utilised nationally.

Analysis and strategic priority-setting regarding individual major investments

Coordinating the allocation of relatively large amounts of funding to research infrastructure of national importance makes it possible to give priority to a few large-scale infrastructures of national importance in a given allocation process. This is usually not possible under the Research Council's other funding schemes and programmes, in part because the amount of funding available is limited, and in part because priority tends to be given to research projects rather than major investments in infrastructure.

Analysis of the grant applications received gives the Research Council an overview over Norway's infrastructure needs, while coordination at the national level can provide a better overview of the investments that are actually made. This will make the Research Council better equipped to set strategic priorities and to target funding announcements for research infrastructure towards specific subject fields and thematic areas as needed.

Cooperation and task-sharing

The Research Council sets clear requirements for cooperation and task-sharing between research institutions and between research institutions and actors from industry, the public administration or the regional health authorities for projects to qualify for funding. Research applications for the infrastructures are largely targeted towards actors outside of the R&D institutions, which creates a culture and practical routines for making research infrastructure accessible to users from spheres outside the host institutions' own researchers. The Research Council stipulates corresponding requirements for cooperation and task-sharing between Norwegian research institutions with regard to funding of Norwegian participation in joint international infrastructures.

Generic e-infrastructure

In recent years, research in many fields has become completely dependent on data management and utilising the increasingly large volumes of data being generated. The development of new sensor technology, digitalisation of research data and advanced data analysis tools mean that more and more research fields need storage capacity for and access to large volumes of research data. Overall, e-infrastructure for research encompasses equipment, operations and related services for high-performance computing, data storage, software systems and high-capacity networks, as well as tools for efficient work flows and software for simulations and analysis of data. The term "e-infrastructure" also refers to digital registries and databases as well as the tools and services for ensuring security and accessibility. It is clear that e-infrastructure is supplying services to more and more research fields that generate and/or use large data volumes and/or employ high-performance computing.

Norway has coordinated e-infrastructure for research and higher education through UNINETT AS and its subsidiary UNINETT Sigma2 AS (Sigma2). UNINETT develops and operates Norway's high-capacity national research and education network, which connects over 200 Norwegian institutions and over 300 000 users to each other and to international research networks. The connection to the research network forms the basis for most other services supplied by UNINETT. Sigma2 is responsible for procurement, operation and further development of the generic e-infrastructure for high-performance computing and data storage. This is more cost-effective than parallel structuring of e-infrastructure solutions within the individual subject areas at the institutions.

Long-term service agreements with the universities in Bergen, Oslo, Tromsø and Trondheim, in addition to basic funding from the Research Council via the National Financing Initiative for Research Infrastructure, make up a significant portion of the financing of Sigma2. In addition, Sigma2 has competition-based funding that includes application-based allocations from national (primarily the

National Financing Initiative for Research Infrastructure) and international instruments. The Research Council also expects that some of Sigma2's costs are covered via R&D projects that receive services from Sigma2.

Generic e-infrastructure has an impact on a great many scientific fields as well as other research infrastructures. Investments in e-infrastructure should be assessed in terms of the resources required for other national research infrastructures. Coordinating investment in national infrastructures helps Norway to tailor investment levels to actual needs and to target activities towards areas where the benefits of investments will be greatest. Centralised coordination of measures also provides opportunities to build bridges between infrastructures and subject fields to promote multidisciplinary research. The Research Council thus seeks to secure adequate, long-term funding for e-infrastructure within the applicable budgetary constraints and commensurate with the needs to be met.

Norwegian Roadmap for Research Infrastructure

The first version of the Norwegian Roadmap for Research Infrastructure was issued in 2010. The Research Council updates the roadmap prior to issuing each new call for proposals under the National Financing Initiative for Research Infrastructure. The main purpose of the roadmap is to identify Norway's needs for updating of research infrastructure in the coming years, within a realistic budget framework. The roadmap consists of two parts, where Part 1 contains area strategies that outline the strategic basis for the Research Council's thinking regarding research infrastructure in specific subject fields, thematic areas and technology areas. Part 2 provides an overview of infrastructures that have received funding thus far under the National Financing Initiative for Research Infrastructure, and includes projects that have not yet been granted funding but have received a positive assessment and are viewed as important for Norwegian research priorities. The Research Council has stringent criteria for which projects to highlight in Part 2 of the roadmap, in terms of quality as well as strategic relevance. Prioritisation is the result of a coordinated review and allocation process. The roadmap also provides funders other than the Research Council with a sound basis for funding decisions.

3 Recommendations

3.1 Recommendations for the ministries:

Maintain an annual budget for investments and remain flexible for increasing needs

The large number of applications received in response to funding announcements under the National Financing Initiative for Research Infrastructure, and the very high quality of many of these, shows that there is both great potential and unmet needs regarding national research infrastructure in Norway. In some areas there is a need to establish new infrastructure, and there will be an ongoing need to upgrade existing infrastructure to ensure that the Norwegian research community has the equipment needed to achieve adequate quality and efficiency.

As of 2018, the annual allocation from the Ministry of Education and Research is nearly NOK 740 million. Based on a long-term ambition to maintain this annual funding level, the Research Council has proposed that future budgets continue at the 2018 level in its input to the update of the Government's Long-term plan for research and higher education.

It is important that Norway maintains its investment volume in national research infrastructure in the coming years. Some of the investments are expected to cover operating costs. Long-term funding is critical to maintaining strategic room to manoeuvre that will benefit Norwegian research over time.

Open access to the use and reuse of research data requires specially adapted research infrastructure. The needs for infrastructure to manage and make data accessible are increasing in most fields. There are also substantial costs associated with operating knowledge-based data infrastructures, given the continual need to develop these to meet the needs of researchers and make it possible to use collected data. Addressing the challenges involved in data management means strengthening national infrastructure. This should be done in cooperation with corresponding international systems and structures when it is possible and appropriate. It is also important to establish mechanisms that help to ensure that the data infrastructure needs of the respective fields are aligned with other research funding for that field.

The enormous increase in data collection, the growing focus on data-driven research, and advancements in data analysis tools are generating a substantially greater need for high-performance computing and storage and accessibility of large data volumes. These data are being generated experimentally and computationally, or collected from sources outside the traditional domains of research. The large amounts of data enable research in new areas, while more efficient high performance computing moves some of the research from the lab to the computer. One ramification of this development is a significantly greater need for e-infrastructure that will surely exceed the framework of current funding levels.

Utilise the resources found on the Norwegian roadmap

Drawing up the Norwegian Roadmap for Research Infrastructure has given the Research Council a tool for presenting major research infrastructure projects that have been quality-assured through a rigorous application review process. The roadmap presents the strategic assessments and priorities in the various areas, placing selected projects in a more strategic context. The ministries will be able to draw benefit from the Research Council's efforts in assessing and quality-assuring proposed projects if they target their individual investments towards projects on the roadmap.

3.2 Recommendations for the R&D institutions:

Prepare detailed plans for managing their role as hosts

Hosting a national research infrastructure involves taking on a big responsibility and in many cases there are financial ramifications. Potential host institutions should draw up detailed plans of how the infrastructure to be established will be administered, made accessible and operated in the long term. Host institutions should make certain that there are qualified personnel with specific responsibilities for day-to-day operations and that the infrastructure is accessible to all relevant users, including those outside the specific institution.

Establishing and operating data infrastructures entails assuming national responsibility for accessibility and secure storage of research data, as well as a commitment to develop and adapt the infrastructure for the relevant user groups. Furthermore, it is important to ensure that data can be safeguarded and managed in a long-term perspective. This means that the institutions must assess the financial commitment and consider business models for long-term, sustainable operation in which the relevant user groups and /or user institutions contribute funding. To ensure sustainability and the support of the research community, it is vital to establish both national and international institutional cooperation. Data infrastructures being established or further developed should strive to build upon existing solutions, technology and networks whenever possible.

Make the costs associated with the infrastructure visible

Research institutions are encouraged to have financial systems in place that distinguish all costs associated with the research infrastructure, including operating costs and depreciation costs related to infrastructure procured by the R&D institution itself. These costs should as far as possible be allocated to the R&D projects that are using the infrastructure and clearly specified in the project budgets. In this way, research funders, including the Research Council, can cover infrastructure-related costs for the individual projects. Expenses related to the use of research infrastructure are defined as approved costs in grant applications for Research Council funding. Research institutions are encouraged to take advantage of this opportunity.

Prioritise research infrastructure within the framework of the basic allocation

Research institutions must continue to make room for new investments in and upgrades and operation of research infrastructure within the parameters of their own budgets.

4 The Research Council will:

Further develop national research infrastructure

The establishment of the National Financing Initiative for Research Infrastructure has given the Research Council a tool for shaping the Norwegian research infrastructure landscape. Assessments of the scientific merit and overall strategic importance of proposed infrastructures will help to identify which investments will be most advantageous for Norwegian research. In order to take adequate account of strategic perspectives, the Research Council works to coordinate this funding initiative with other instruments and funding schemes at the Council.

Follow up Norway's participation in international cooperation on research infrastructure

Norway participates in European cooperation on research infrastructure to provide the Norwegian research community with access to infrastructures that Norway cannot finance on its own. Decisions regarding participation will be targeted towards international cooperation that supports the priority areas set out in the Long-term plan. Norway's participation in the distributed ESFRI infrastructures has the greatest strategic benefit in areas where Norway already has research infrastructures that can be coordinated and further developed in cooperation with other European countries.

Promote optimal use of infrastructures

The Research Council's centralised allocation process provides an overview of existing infrastructures at any given time. The requirement of making national research infrastructure accessible to many users will also help to promote more effective use.

Enhance the innovation capacity of industry and the public sector

The Norwegian business sector is mainly comprised of small and medium-sized companies. The Research Council would like to see greater research activity among these companies – and wider application of the research results. The Council works to promote an innovative business sector that carries out more research activity in collaboration with the public sector, and views the public sector

as an important partner and market for developing innovative solutions.¹² The Research Council encourages companies and public entities to collaborate with Norwegian and international researchers on a broader scale to better exploit research results for development and innovation. Up-to-date research infrastructure is a critical factor for achieving this objective, and the Council's investments in infrastructure are intended to support such collaboration.

Promote accessibility of research data

Access to high-quality research data can promote innovation and knowledge-based management. The Research Council works to increase the accessibility and reuse of research data for the business and public sectors by means of requirements and guidelines for R&D projects and through funding of data infrastructures of national importance.

Promote efficient management, operation and accessibility of infrastructure, in keeping with international principles

The Research Council places emphasis on sound organisation and operation of the infrastructures in its funding announcements, application review process, and follow-up of projects. The infrastructures are to be established in keeping with international principles for user access, management of data and findings, and steps to make these openly accessible.

5 Attachment:

Principles for priority-setting and allocation of funding under the National Financing Initiative for Research Infrastructure

Funding for national infrastructure is allocated via thematically open funding announcements under the National Financing Initiative for Research Infrastructure. The funding announcements are followed by an assessment and prioritisation process that gives consideration to both scientific merit and strategic relevance, based on two respective sets of criteria. If for strategic reasons more targeted funding announcements are called for, this will be considered.

It is essential that research infrastructure projects exhibit high scientific merit to be deemed worthy of funding. The application review process includes a scientific review carried out by international referees and a strategic assessment by the Research Council administration. The review by the international referees will assess the extent to which the proposed research infrastructure will facilitate research activities of high scientific quality. This assessment serves as important input for the Research Council in further processing of the applications, in which the Research Council administration assesses the national importance and strategic relevance of the research infrastructure.

The scientific experts normally assess applications in relation to the following points:

- the benefit to research of the infrastructure in terms of scientific quality and the impact of the infrastructure on the research activities in need of that infrastructure;
- the extent to which the infrastructure serves to promote the internationalisation of Norwegian research;
- the infrastructure's relevance to existing industries and/or newly established companies and its

¹² The Research Council's Strategy for Innovation in the Public Sector, 2018–2023.

contribution to enhancing the competitive position of Norwegian industry internationally;

- the infrastructure's relevance to society and potential to contribute knowledge and expertise of importance to society;
- the extent to which the infrastructure project is feasible with regards to the technical solutions, available expertise, and personnel as well as financial resources involved;
- the extent to which the plans for establishment and operation are well-suited for the tasks in the project;
- interaction between new infrastructure and any existing infrastructures;
- quality of the project plans and competence of the project management team.

Grant applications for national infrastructures must satisfy the strategic requirements and guidelines set out in the funding announcements. Applications will also be assessed on the basis of the following criteria:

- the infrastructure's national importance;
- the extent to which the infrastructure will make use of national research expertise and help to promote national network-building;
- whether the infrastructure will contribute to a satisfactory distribution of tasks between relevant research groups;
- the extent to which the plans for establishment and operation are well-suited for the tasks in the project;
- the degree to which responsibility for administrative management and establishing and operating the infrastructure is considered satisfactory;
- how the infrastructure reflects the overall institutional objectives, and its importance for supporting strategic priorities and national strategies;
- whether good plans are in place to make the infrastructure accessible to users outside the host institutions;
- whether the infrastructure supports national industrial priorities (when relevant);
- whether the infrastructure contributes to long-term competence building in research areas that are expected to be of major importance to Norway;
- whether the infrastructure reflects and reinforces the host institutions' strategic plans and priorities, and plans are in place for funding the operation of the infrastructure once the project period is concluded;
- whether the infrastructure is of relevance to Norwegian society.

After the conclusion of the application review and allocation process, projects that are ranked as "excellent" in terms of both scientific merit and strategic orientation but have not been granted funding may be specifically identified on the Norwegian Roadmap for Research Infrastructure.. The assessment criteria employed by the referee panels and the Research Council administration, respectively, are described in greater detail in a separate attachment that may be downloaded via the call for proposals on the Research Council website.



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