

```
def _operation == "mirror_2")
  mirror_sel.use_x = false
  mirror_sel.use_y = true
  mirror_sel.use_z = false
elif _operation == "mirror_2")
  mirror_sel.use_x = false
  mirror_sel.use_y = false
  mirror_sel.use_z = true

#selection at the end =
mirror_ob.select= 1
modifier_ob.select=1
by.context.some.objects
print("Selected" + str(mirror_ob.select) + "\n")
new = by.context.some.objects
for obj in new:
  print(obj.name)
```

**FINLAND'S
STRATEGY AND
ROADMAP FOR
RESEARCH INFRA-
STRUCTURES 2014–2020**
Interim review report 2018



ACADEMY OF FINLAND

FINLAND'S STRATEGY AND ROADMAP FOR RESEARCH INFRA- STRUCTURES 2014–2020

Interim review report 2018



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1 Summary

Research infrastructures form a reserve of research facilities, equipment, materials and services. As such, they enable research and development at various stages of innovation, while supporting organised research, researcher training and teaching. They also support and develop research and innovation capacity. Research infrastructures can be centralised, that is, based in a single location. They can also be distributed or virtual, and can form mutually complementary wholes and networks.

The interim review of the strategy and roadmap for Finnish research infrastructures 2014–2020 was conducted in 2017–2018. The objective of the interim review was to investigate the topicality of the research infrastructure strategy and its procedures, as well as to assess the progress, in terms of scientific quality and organisational development, of infrastructures that are included on the roadmap or are not included but have received funding from the Finnish Research Infrastructure Committee (FIRI Committee).

The interim review found that the execution of the strategy for 2014–2020 has progressed as planned and the efficiency of coordination at the national level has improved. To expand the overall national picture, the FIRI Committee has carried out, in cooperation with other parties, assessments of the infrastructure fields of universities, universities of applied sciences and university hospitals, as well as arranged opportunities for industry and discipline-specific dialogue. Through the FIRI funding calls, the Committee has, in addition to supporting high-level scientific research, encouraged infrastructures to openness in usage policies, systematic data management and broader cooperation between actors. Furthermore, the Committee

has developed the open-access research infrastructure database in cooperation with the Open Science and Research Initiative.

The host organisations of national and international research infrastructures play a key role in the development of knowledge platforms facilitated by the infrastructures, together with other actors. In addition to researchers, potential customers of the infrastructures include the public sector (hospitals etc.), national and international companies, as well as NGOs. The optimal utilisation and management of infrastructure investments often requires diverse cooperation, clear usage policies and fees, and joint development.

The interim review of the roadmap found that a total of 32 research infrastructures met the criteria for national research infrastructures and the requirements of the strategic policy set by the FIRI Committee.

The research infrastructures included in the roadmap were divided into four categories:

- **A: Very advanced research infrastructures**, which met all criteria and whose operations are established or soon to be established;
- **B: Advanced research infrastructures**, where operations still require development in certain areas, as found in international peer reviews;
- **C: Promising research infrastructures**, which show clear potential to provide support for high-level scientific research but are still young as an organisation; and
- **D: Research infrastructures under observation**, which must take measures to implement the significant development needs found in the international peer review in order to retain their place on the roadmap after 2020.

In the future, this categorisation will influence the content of FIRI applications and evaluation principles; very advanced infrastructures will be evaluated more lightly, while funding for advanced and monitored research infrastructures will be influenced by their advancement of the development targets identified in the review.

The latter period of the strategy in the years 2018–2020 will focus on further developing the principles used to identify key infrastructures, while simultaneously improving the openness and collaborative use of infrastructures. To extend the financing base of infrastructures, discussions will be held between various parties to develop the principles and to identify opportunities for cooperation, both at the national level and between research infrastructures. To enhance Finland's international scientific impact, steps must be taken to reinforce national coordination, particularly in the European Strategy Forum on Research Infrastructures (ESFRI), the European Union Research and Innovation Programme for 2014–2020 (Horizon 2020), and in the preparations for the Ninth EU Framework Programme (FP9). In addition to the European level, the Committee participates actively in the development of Nordic research infrastructure cooperation. Between the years 2018–2020, the Committee will establish the principles that lay the foundation for the new research infrastructure strategy and roadmap, to be devised in 2021.

Finland's research infrastructures

Infrastructures on the roadmap.

FIELDS OF SCIENCE	A. VERY ADVANCED (10)	B. ADVANCED (14)	C. PROMISING (4)	D. UNDER OBSERVATION (4)
Social sciences and humanities (6)	FIN-CLARIN	CESSDA Finland		Finna
		ESS Finland		
		FinELib		
		FMAS		
Environmental sciences (6)	FINMARI INAR RI	EISCAT-3D	FinBIF	
		EPOS Finland	oGIIR	
Energy (0)				
Biological and medical sciences (10)	BBMRI Finland Biocenter Finland ELIXIR Finland EuBI Finland	EU-OPENSREEN		EATRIS
		INFRAFRONTIER Finland		
		Instruct Finland		
		NaPPI		
		NVVL		
Physical sciences and engineering (7)	BIOECONOMY	Euclid Finland	Aalto Ice Tank	MAX IV Finland
		JYFL-ACCLAB	RAMI	
		OtaNano		
E-infrastructures and mathematics (3)	CSC RI PRACE Finland			FGCI

Finland's memberships in international research infrastructures.

	FIELDS OF SCIENCE
CESSDA-ERIC	Social sciences and humanities (3)
CLARIN-ERIC	
ESS-ERIC	
EISCAT ja EISCAT-3D	Environmental sciences (6)
EURO-ARGO	
GBIF	
ICDP	
ICOS-ERIC	
IODP	
EFDA-JET	Energy (3)
ITER	
JHR MTR	
BBMRI-ERIC	Biological and medical sciences (5)
EATRIS-ERIC	
ELIXIR	
EMBL	
INFRAFRONTIER	
CERN	Physical sciences and engineering (7)
ESA	
ESO	
ESRF	
FAIR	
MAX IV	
NOT	
IML	E-infrastructures and mathematics (3)
NeIC	
PRACE	

Abbreviations and full names of research infrastructures can be found on pages 21–22.



2 Interim review of the strategy for 2014–2020

2.1 Strategy for 2014–2020

The Finnish Research Infrastructure expert group approved the research infrastructure strategy and roadmap 2014–2020 document in December 2013 (1). In the strategy, the long-term development directions of Finnish research infrastructure operations were defined for the first time. The strategy and its central sets of measures have directed the development work carried out by both the FIRI Committee and the research infrastructure ecosystem as a whole in reinforcing the quality, impact, capacity for renewal, and internationalisation of research.

2.2 Definition of research infrastructure

Research infrastructures form a reserve of research facilities, equipment, materials and services. As such, they enable research and development at various stages of innovation, while supporting organised research, researcher training and teaching. They also support and develop research and innovation capacity.

Research infrastructures consist of equipment, knowledge networks, databases, multidisciplinary research centres, research stations, collections, libraries and related user services, where these are fundamental to research. In general, major research infrastructures are international and open to collaborative use, providing cooperation opportunities to both Finnish and international researchers and other actors.

Research infrastructures can be centralised, that is, based in a single location. They can also be distributed or virtual, and can form mutually complementary wholes and networks.

In addition to the traditional natural sciences, the importance of research infrastructures has also increased in other fields. At the same time, the number of distributed and virtual international research infrastructures has seen particularly strong growth. Traditionally, research infrastructure has been perceived as a location-based research environment that supports research experiments, such as the European Organisation for Nuclear Research CERN and the European Molecular Biology Laboratory EMBL.

Digitalisation, scientific progress and increasingly close international cooperation have also formed a foundation for the construction of strong, network-based and data-intensive research infrastructures, such as the Biobanking and Biomolecular Resources Research Infrastructure BBMRI, the European Life Science Infrastructure for Biological Information ELIXIR, the Common Language Resources and Technology Infrastructure FIN-CLARIN, and the Integrated Carbon Observation System ICOS.

2.3 Finland's research infrastructure ecosystem

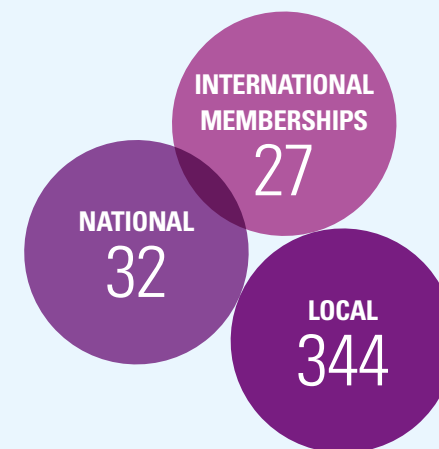
In addition to infrastructures on the national roadmap, the Finnish research infrastructure ecosystem comprises several international infrastructures that Finland has joined through (state) agreements. A portion of the national infrastructures on the roadmap are the Finnish nodes, or centres, of international infrastructure networks.

From the perspective of their host organisations, local research infrastructures also have an important role as a research environment that provides a platform for cooperation with various partners in areas such as teaching, development and innovation. Distributed and virtual infrastructures can also open up opportunities to participate in broader research infrastructure cooperation, thereby strengthening the national or international role of a local or national infrastructure. (2)

In addition to the research infrastructures, their host organisations as well as several ministries and national funders (Business Finland and the Academy of Finland) participate in the administration and funding of the research infrastructure ecosystem. Each party is responsible for the development of the ecosystem. The optimal utilisation and management of infrastructure investments is usually achieved through diverse cooperation and interaction (Figure 1).

Figure 1. Finland's research infrastructure ecosystem

In addition to infrastructures on the national roadmap, the Finnish research infrastructure ecosystem comprises several international infrastructures that Finland has joined through (state) agreements. The figures refer to the number of infrastructures in each group.



2.4 Key objectives of the strategy

The systematic development of research infrastructures requires a consistent and long-term research infrastructure policy that takes into account the operational strategies of research infrastructures, host organisations and other stakeholders.

Key objectives of the strategy for 2014–2020:

- Long-term development of all research infrastructures
- Improvements to the openness and collaborative use of research infrastructures
- Shoring up of the funding base of research infrastructures
- Provision of a firm basis, by the roadmap, for the methodical development of research infrastructures
- Evaluation of the impact and significance of research infrastructures

To achieve these objectives, the FIRI Committee has devised a programme of measures. A majority of the measures planned for the years 2015–2017 have been implemented. The purpose of the measures has been to improve the clarity and coherence of the overall picture of the national research infrastructure field, as well as to promote the openness and scientific impact of the infrastructures.

2.5 Finnish Research Infrastructure Committee

As the Finnish Research Infrastructure expert group prepared the strategy for 2014–2020, a need emerged to improve the efficiency of national coordination between infrastructures, the predictability of funding decisions, and the transparency of decision-making in Finland. As a result, section 5 of the Government Proposal to amend the Act on the Academy of Finland proposed the establishment of a national Research Infrastructure Committee (FIRI Committee).

Tasks of the Committee:

- to monitor and develop national and international research infrastructure operations
- to propose a long-term plan for research infrastructures to the Board of the Academy
- to decide on the selection of research infrastructure projects and oversee their progress
- to attend to other matters concerning research infrastructure, as assigned by the Board of the Academy

The duties of the Committee also include the funding of research infrastructure projects by funds assigned in the annual state budget.

Under the Act, the Board of the Academy appoints the chair and members of the Committee after consulting with the Ministry of Education, Science and Culture. The chair and members are required to possess diverse experience in the operations of organisations within the research and innovation systems, as well as an understanding of the significance of research infrastructures. Furthermore, the members are required to be recognised researchers or science policy experts. Under the Act, chairmanship or membership of the FIRI Committee may be held by the personnel of the Administration Office of the Academy of Finland.

Between 2014–2017, the FIRI Committee and other actors have advanced the achievement of the strategy’s goals as follows:

1. Long-term development of all research infrastructures

- The Committee has drafted principles for identifying and prioritising key research infrastructures. The principles have been further specified in the evaluation of FIRI applications.
- In cooperation with various actors, the Committee has advanced the development of research infrastructure activities and their integration as part of the strategic planning of research organisations.
- The FIRI Committee, the Ministry of Education, Science and Culture and the Academy of Finland have advanced the coordination of international infrastructure activities, in particular ESFRI, at the national level.
- Seminars organised by the Committee have discussed the importance of infrastructures and their development together with infrastructure operators.
- In cooperation with various actors, the Committee has carried out situation assessments to expand the overall picture on the Finnish infrastructure field:
 - Assessment of the research infrastructures of universities, carried out in connection with the State of Scientific Research in Finland 2014 review (2)
 - Participation in the infrastructure report for universities of applied sciences (3)
 - Participation in the report on the use of public research infrastructures and development platforms by companies (4)
 - Research infrastructure assessment of university hospitals in cooperation with the Ministry of Social Affairs and Health and the National Institute for Health and Welfare

2. Improvements to the openness and collaborative use of research infrastructures

- The Committee has encouraged cooperation between infrastructures in connection with the annual funding calls.
- The Committee has introduced the openness of the infrastructures’ usage policies as part of its evaluation.
- The Committee has required that the development of data policies of infrastructures comply with the principles of open science.
- In cooperation with the Open Science and Research Initiative, the Committee has designed and developed the open-access Research Infrastructure Database (5).

4. Provision of a firm basis, by the roadmap, for the methodical development of research infrastructures

- The Committee has made information related to research infrastructures included in the roadmap 2014–2020 or funded by the Committee openly accessible in the Research Infrastructure Database.
- In the annual funding calls, the Committee has directed a significant portion of its funding to research infrastructures included in the roadmap.
- The Committee has conducted an interim review of the strategy and roadmap for Finnish research infrastructures.

3. Shoring up of the funding base of research infrastructures

- The Committee has organised annual funding application rounds.
- The Committee has emphasised the crucial role of host organisations in terms of strategic planning in funding applications (the organisations apply and prioritise their research infrastructures).

5. Evaluation of the impact and significance of research infrastructures

- The Committee has organised industry- and discipline-specific discussion panels.
- The Committee has adopted the monitoring of scientific impact and significance as part of the reporting on research infrastructures.

2.6 Measures implemented under the strategy between 2014–2017

The FIRI Committee began its work in the autumn of 2014, and has since then been responsible for coordinating and monitoring the implementation of the strategy for 2014–2020.

The measures have been implemented commendably, and it can be observed that the importance of research infrastructures in the creation of interesting and impactful knowledge environments has received increased attention in the planning activities of research organisations and other national actors. Finland has also actively developed operating models and solutions for increasing the openness of infrastructures and to meet the increasing needs for the collection, storage and availability of data and information.

Based on the strategy and the FIRI funding calls, the Committee has, during the current period, recommended to the relevant ministries that Finland should seek membership in eight international research infrastructure networks. Negotiations with the EISCAT-3D, MAX IV and PRACE research infrastructures have already reached completion. Infrastructures still in the preparatory phase are EuroBioimaging, Instruct, EU-OPENSREEN, AnaEE and EPOS.

Membership recommendations are always the result of extensive strategic assessment. The assessment takes into account the infrastructure's membership criteria, the added value provided by membership, and the support of the researcher community and host organisations for the utilisation of the membership. The FIRI Committee views memberships in international infrastructures as avenues to aid in the reinforcement of high-level Finnish research and the increase of international visibility. Due to this, the Committee has considered it important that top-level research in various fields is provided broad support through memberships in different infrastructures. International memberships are also significant for the advancement of areas such as development and innovation activities, education and citizen science, which must also be considered when developing infrastructure activities.

2.7 Measures to be implemented in 2018–2020

During the first four-year period of the roadmap, the operating environment of research infrastructures has changed and infrastructure activities have become more strategically integrated in planning work, both at the national level and within organisations. The need for strategic planning and cooperation between different actors will continue to increase in the future in order to obtain the greatest potential benefits from infrastructure investments.

Within the international framework, Finnish research infrastructure activities are also increasingly closely linked to European developments. Finnish infrastructure experts are actively involved in the Horizon 2020 infrastructure committee, as well as in the ESFRI and its subgroups (6, 7). Finnish experts participate in the preparation of common European development projects, such as the European Open Science Cloud (EOSC) and Synchronising research infrastructure roadmapping in Europe (InRoad). In addition, the experts participate in joint Nordic infrastructure activities. Finnish infrastructure operators are, in turn, actively involved in influencing and developing the infrastructures of their respective fields, both in Europe and globally.

The possibilities opened up by scientific advancement and digitalisation challenge the capabilities of research infrastructures in providing services to various user groups for the storage and processing of produced data. Infrastructures are also expected to develop the capacity to provide services to an increasingly broad and diverse user base in research, development and innovation activities, support for education, and other functions.

The objectives of the strategy for 2014–2020 and their related measures continue to be important. Implementation of the measures also provides the opportunity to increase the number of actors participating in the development and maintenance of infrastructures, thereby improving their impact. Several measures are planned to be implemented during the latter period of the strategy in order to achieve its objectives.

Measures to be implemented in 2018–2020:

1. Long-term development of all research infrastructures

- Further developing the principles used to identify key national and international research infrastructures and develop their operations
- Increasing the evaluation and visibility of research infrastructure activities so as to facilitate the demonstrability of infrastructures as platforms that are important for the quality and impact of research
- Organising FIRI seminars in order to develop operations and share good practices

2. Improvements to the openness and collaborative use of research infrastructures

- Developing the usage policies, cooperation and openness of research infrastructures, including in innovation activities
- Participating actively in national and international open science and data management development projects

4. Provision of a firm basis, by the roadmap, for the methodical development of research infrastructures

- Reinforcing international (Horizon 2020, ESFRI, Nordic countries) research infrastructure activities and their coordination at the national level
- Establishing principles to lay the foundation for the new research infrastructure strategy and roadmap, to be devised in 2021

3. Shoring up of the funding base of research infrastructures

- Organising annual calls
- Investigating the potential for research infrastructure funding by other funding organisations
- Encouraging research infrastructures in strengthening their funding base and expanding their sources of funding to ensure funding for the full infrastructure lifecycle

5. Evaluation of the impact and significance of research infrastructures

- Supporting, together with other actors, the broader commercial and societal utilisation and application of the potential that is supportive of the innovation and development of expertise of research infrastructures
- Developing a model for evaluating international memberships
- Further developing the methods for evaluating the scientific impact and significance of research infrastructures





3 Finland's research infrastructure roadmap 2014–2020

The roadmap for national research infrastructures is a list of key research infrastructures in Finland, which are either under development or will be newly required over the next 10–15 years. The plan also concerns a major upgrade of existing research infrastructures.

Published in 2014, the strategy and roadmap of Finnish research infrastructures have proven to be excellent tools for the development and execution of national and international research infrastructure policy. The strategy and its programme of measures have clarified national objectives and their implementation. As a result, they have facilitated the systematic development of the research infrastructure ecosystem.

The inclusion of a research infrastructure in the roadmap is a strategic selection that is based on international peer review. The research infrastructures included in the roadmap are prioritised service entities that meet the criteria for national research infrastructures. The roadmap provides a solid foundation for other strategic decisions on the development of research infrastructures, such as those related to Finland's membership in international research infrastructures. The roadmap also serves as a basis for the planning and prioritisation of long-term infrastructure investment and their funding.

3.1 Interim review of the roadmap

The objective of the interim review of research infrastructures was to assess the progress, in terms of scientific quality and organisational development, of infrastructures that are included in the roadmap or are not included but have received FIRI funding. The objective was also to identify the research infrastructures that demonstrate an internationally high level of scientific quality and are supportive of Finland's objectives in science policy.

3.1.1 Evaluation criteria for research infrastructures

Research infrastructures included in the roadmap must create international interest, attract top-level researchers to Finland, produce added value in their research, and markedly raise the standard of research in Finland in their respective field. The research infrastructures must also support the direction of scientific impact outside the scientific community to public services, culture, the economy, health and the environment.

In selecting research infrastructures for the roadmap, the following questions were evaluated:

- Does the infrastructure enable the performance of high-level research?
- How extensive is the potential user base of the infrastructure?
- How does the infrastructure support Finnish research that is cross-disciplinary, multidisciplinary and high-quality? How does it accomplish this internationally?
- Do the services provided by the infrastructure and its data administration comply with the principles of open science?
- Is the organisational structure of the infrastructure sufficiently supportive of the production of service?

Detailed descriptions of the evaluation and selection are included in Appendix 1.

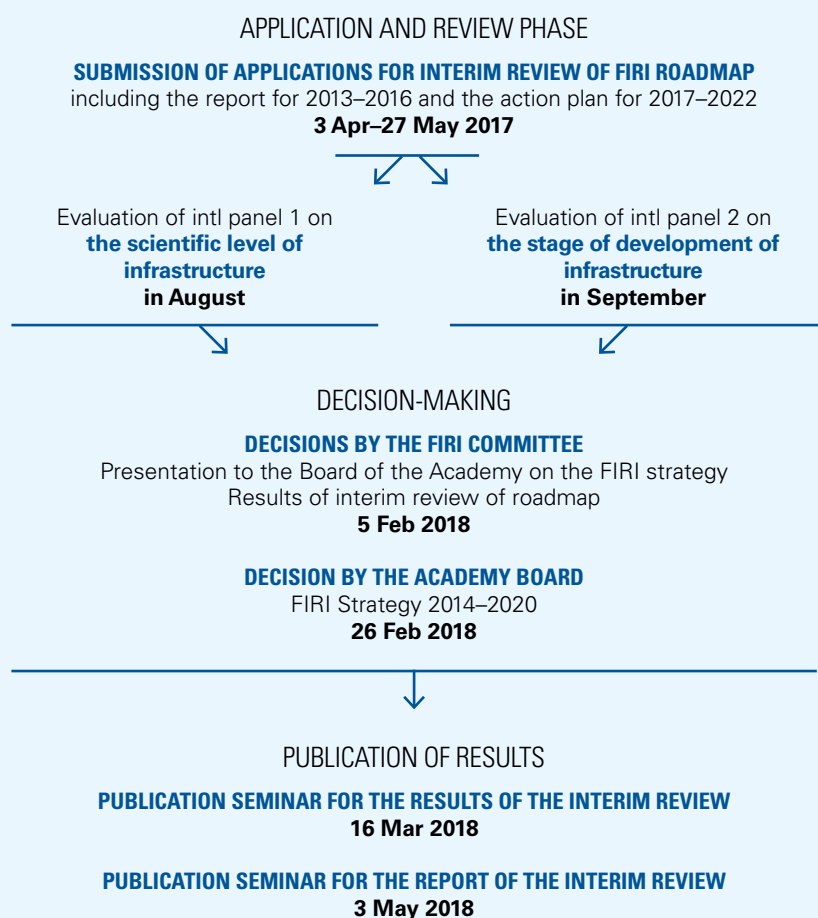
3.1.2 Selection process for research infrastructures

The interim review was carried out for those research infrastructures whose applications included an action plan for the years 2017–2022 and a report from the years 2013–2016. The infrastructures were asked to report the number of publications made with the help of their services, the number of users of the services and the openness of use, the total funding received by the infrastructure, the cooperation with public and private-sector actors, and the patents, inventions and new technologies developed in their activities. In addition, the infrastructures were asked to report on their impact beyond academia.

Each application was reviewed by two international panels. One of the panels evaluated the research infrastructures for their scientific quality, potential for renewal and impact, while the second panel focused on evaluating the organisational level of development of the research infrastructures in terms of their capability to provide their stated services.

As a whole, the evaluation covered a broad array of issues and therefore utilised unprecedentedly extensive data collected on the operations of the infrastructures. The results will be presented in detail in a background memorandum for the interim review.

Figure 2. Evaluation and decision-making process in the interim review of the roadmap for 2014–2020.



3.1.3 Results of the interim review

The interim review evaluated a total of 41 infrastructures, including two international research infrastructures, NeIC (Nordic e-Infrastructure Collaboration) and ICOS (Integrated Carbon Observation System). As a result of the review, the roadmap for 2018–2020 consists of 32 research infrastructures of differing levels of quality and organisational maturity. The NeIC and ICOS research infrastructures are part of Finland’s international memberships (Figure 3). Three new infrastructures were included in the roadmap: Aalto Ice Tank, FinBIF (Finnish Biodiversity Info Facility) and RAMI (RawMATTERS Infrastructure). As a result of the interim review, two infrastructures were removed from the roadmap: DIPI (Digital Preservation, formerly TTA-KDK-PAS) and XFEL XBI (European X-ray Free-Electron Laser and its Integrated Biology Infrastructure). Furthermore, five infrastructures not on the roadmap but which have received funding by the FIRI Committee did not meet the criteria for roadmap infrastructures and therefore remained outside the roadmap. Another infrastructure left out of the roadmap was CTA (Cherenkov Telescope Array), which failed to submit an application for the interim review.

The research infrastructures included in the roadmap are divided into four groups. The groups are based on the strategic policy by the FIRI Committee and the international peer review, which based its evaluations on the criteria for national research infrastructures (Appendix 1):

- **A: Very advanced research infrastructures**, which fulfilled all criteria and whose operations are established or soon to be established
- **B: Advanced research infrastructures**, which fulfil the criteria with the exception of some development needs found by the international peer review. These development needs must be addressed.
- **C: Promising research infrastructures**, which show clear potential to provide support for high-level scientific research but are still young as an organisation
- **D: Research infrastructures under observation**, which were found by the international peer review to have significant development needs. The fulfilment of these development needs is a prerequisite for their continued inclusion in the roadmap after 2020.

Detailed presentations of all infrastructures on the roadmap are available in the Finnish Research Infrastructure Database. (infras.openscience.fi).

3.2 International research infrastructures

Extensive research infrastructures constructed jointly by several states have complex structures and are challenging to administer. The uniqueness of the research infrastructure as an investment that promotes scientific competitiveness must be considered when considering Finland's participation in a significant international infrastructure or the establishing of such an infrastructure in Finland.

Finland is currently a member in 27 international research infrastructures (Table 1). The interim review of the roadmap for 2014–2020 included no research infrastructures that Finland has been a member of since the formation of the FIRI expert group. In the future, the significance of international memberships to Finnish scientific research will be assessed every five years.

In order to harmonise the related judicial practices, the European Union has issued a regulation (European Consortium on Research Infrastructures, ERIC) establishing a legal framework for research infrastructures. This is intended to ease the administration and operations of extensive, multidisciplinary research infrastructures. European research infrastructures on the ESFRI (European Strategy Forum for Research Infrastructures) roadmap have also devised their own legal frameworks equivalent to ERIC, such as the ECA (ELIXIR Consortium Agreement) by the ELIXIR initiative.

Finland is a member in eleven infrastructure networks that have developed out of the ESFRI roadmap. At the same time, Finland is responsible for maintaining the competitiveness of its national centres (nodes). Joining a network is always the result of an extensive strategic assessment. The assessment takes into account the infrastructure's membership criteria, the added value provided by membership, and the strong support of the researcher community and host organisations for the utilisation of the membership.

Finland is a host country to the ICOS-ERIC network, which is headquartered in the University of Helsinki Kumpula campus in Helsinki. Finland is also involved in the planned joint hosting of the EuroBioimaging (EuBI) infrastructure between Finland, Italy and the EMBL. In the plan, the head office of the EuBI network would be based at the University of Turku in Finland, while the centres for medical and biological imaging would be located in Italy and at the EMBL.

Figure 3. Infrastructures on the roadmap 2014–2020 and their grouping based on the interim review.

ROADMAP			
32			
A: VERY ADVANCED	B: ADVANCED	C: PROMISING	D: UNDER OBSERVATION
10	14	4	4
BBMRI Finland*	CESSDA Finland*	Aalto Ice Tank	EATRIS Finland*
Biocenter Finland	EISCAT-3D (Finland*)	FinBIF	FGCI
BIOECONOMY	EPOS Finland	oGIIR	Finna
CLARIN Finland*	ESS Finland*	RAMI	MAXIV Finland*
CSC RI	Euclid Finland*		
ELIXIR Finland*	EU-OPENSREEN Finland		
EuBI Finland	FinELib		
FINMARI	FMAS		
INAR RI **	INFRAFRONTIER Finland*		
PRACE Finland*	INSTRUCT Finland		
	JYFL-ACCLAB		
	NaPPI Finland		
	NVVL		
	Otanano		

* Membership of international research infrastructure (Table 1)

** Membership and headquarters (ICOS) in Finland (Table 1)

Finland's intl memberships of NeIC and ICOS infrastructures have been reviewed (Table 1)

Table 1. Finland's memberships in international research infrastructures.

Environmental sciences (6)	Social sciences and humanities (3)	Biological and medical sciences (5)	Energy (3)	Physical sciences and engineering (7)	E-infrastructures and mathematics (3)
EISCAT (+3D) European Incoherent Scatter Association	CESSDA Consortium of European Social Science Data Archives	EMBL European Molecular Biology Laboratory	ITER International Thermonuclear Experimental Reactor, <i>TEM</i>	CERN European Organization for Nuclear Research	IML Mittag-Leffler Institute
GBIF Global Biodiversity Information Facility	CLARIN Common Language Resource and Technology Infrastructure	EATRIS European Advanced Translational Research Infrastructure	EFDA-JET Joint European Torus, <i>TEM</i>	ESA European Space Agency, <i>TEM</i>	NelC Nordic e-Infrastructure Collaboration
ICDP International Continental, Scientific Drilling Program	ESS European Social Survey	BBMRI Biobanking and Biomolecular Resources RI	JHR MTR Jules Horowitz Materials Testing Reactor, <i>TEM</i>	ESO European Southern Observatory	PRACE Partnership for Advanced Computing in Europe
IODP Integrated Ocean Drilling Program		ELIXIR European life science infrastructure for biological information		ESRF European Synchrotron Radiation Facility	
ICOS Integrated carbon observation system <i>Hosting country</i>		INFRAFRONTIER The European Infrastructure for phenotyping and archiving of model mammalian genomes		FAIR Facility for Antiproton and Ion Research	
EURO-ARGO European contribution to the ARGO Program, <i>LVM</i>				MAX IV Synchrotron Radiation Facility	
				NOT Nordic Optical Telescope	

4 Research infrastructure funding

The funding of research infrastructures is long-term, as the lifecycles of infrastructures may be decades long. In Finland, the longevity of infrastructure funding is achieved through collaboration. The Academy of Finland provides funding primarily for investment costs during the construction phase of the research infrastructure, that is, for the procurement of equipment and systems and the start-up of services. In addition, the Academy funds the implementation of crucial upgrades for existing infrastructures. The Academy requires that the funded equipment be part of a Finnish research infrastructure that is currently operational or under construction and which is openly available for shared use by the scientific community. The principle of FIRI activities is that the permanent operating costs of the infrastructures are paid for by their respective host organisations. In FIRI funding applications, the applicants are always the host organisations of research infrastructures.

While the research infrastructures often have broad funding bases, the primary source of funding for their operations is their host organisation. According to the information provided for the interim review, the roadmap's research infrastructures have total funding needs of approximately 600 million euros for the years 2018–2022.

4.1 Academy of Finland funding for research infrastructures

The Academy of Finland organises the annual FIRI funding application round for research infrastructures, which is aimed at improving the quality, capacity for renewal, competitiveness and multidisciplinary of Finnish research, as well as to increase the appeal of Finnish research environments. A further objective is to promote national and international collaboration between universities, research groups and researchers. The research infrastructures are used to support researcher training and the formation and utilisation of scientific expertise and knowledge capital. FIRI funding may also be granted for expenses incurred by memberships in national and international research infrastructures, such as membership fees.

In addition to FIRI funding, the Academy reimburses approximately 19 million euros in research infrastructure membership fees each year.

In addition, the research conducted by the research infrastructures is funded partially by other research funding by the Academy, such as Academy Project funding granted by the Academy's research councils.

4.2 Effects of the roadmap interim review on FIRI funding calls

As of 2018, the FIRI funding calls will be influenced by the infrastructure's inclusion in the roadmap as well as its designated category (Table 2 and Figure 3).

In future, all applications will continue to be evaluated on the level development of their infrastructure; however, infrastructures in the very advanced or advanced categories and international member infrastructures no longer need to present the ways by which they have advanced scientific research in their applications. For these infrastructures, the results of the 2018 interim review are sufficiently convincing to be considered reliable until the year 2020. Scientific advancement will continue to be evaluated yearly for applications filed by promising infrastructures, infrastructures under observation, and infrastructures outside the roadmap (including new initiatives).

Future FIRI calls will also evaluate how infrastructures in the advanced category have been able to address the development needs identified in the interim review. It is a prerequisite of continued FIRI funding that these development needs are addressed. In the case of infrastructures under observation, the identified development needs are significant enough that their addressing is prerequisite to both continued FIRI funding and the continued inclusion of said infrastructure in the roadmap, which will be next updated in 2021.



Table 2. Evaluation criteria for the roadmap 2014–2020 categories, international memberships and infrastructures outside the roadmap

Review target in FIRI calls	Research infrastructures included in the roadmap				E. Other international memberships	F. Outside roadmap
	A. VERY ADVANCED	B. ADVANCED	C. PROMISING	D. UNDER OBSERVATION		
Level of advancement	Yes	Yes	Yes	Yes	Yes	Yes
Promotion of science	No	No	Yes	Yes	No	Yes
Development needs identified during the interim review	No	Yes	No	Yes	No	No
Funding in FIRI call						
Roadmap call	Eligible	Eligible	Eligible	Eligible	Eligible	Ineligible
New initiatives call	Ineligible	Ineligible	Ineligible	Ineligible	Ineligible	Eligible

5 Conclusions of the strategy and roadmap 2014–2020 interim review

Conclusions of the strategy interim review

The research infrastructure strategy and roadmap 2014–2020 interim review and the research infrastructure applications and reports evaluated in connection with it demonstrate that the strategic development of research infrastructures plays an important role in the optimal direction resources in order to achieve impact. The impact of research infrastructures extends beyond research and the scientific community.

In order to expand the overall national picture on research infrastructures during the first four years of the strategy period, the Committee has, in cooperation with other parties, carried out assessments of the infrastructure fields of universities, universities of applied sciences and university hospitals, as well as arranged opportunities for industry- and discipline-specific dialogue. The objective for the latter strategy period in the years 2018–2020 is to further develop the principles used to identify key infrastructures. At the same time, the openness and joint use of infrastructures will be improved, and particular attention will be paid to cooperative activities with the private sector and other societal actors. To extend the funding base of infrastructures, discussions will be held between various parties to develop the principles and to identify opportunities for cooperation, both at the national level and between research infrastructures. To further enhance Finland's impact on international arenas, national coordination must be strengthened, particularly in relation to the ESFRI, Horizon 2020, FP9 preparations and Nordic cooperation. Between the years 2018–2020, the Committee will also establish the principles that lay the foundation for the new research infrastructure strategy and roadmap, to be devised in 2021.



Conclusions of the roadmap interim review

The objectives set for national and international research infrastructures aim at promoting collaboration between different actors in order to reinforce the joint use, openness and funding base of the infrastructures. Further development is still required in areas such as evaluation of the infrastructures' impact, development of flexible usage policies, and the practical implementation of lifecycle thinking for infrastructures. Administration and direction and the management of cooperation structures and data policies of large-scale, distributed or virtual research infrastructures require suitable operating models and skills that should be systematically developed both in Finland and internationally.

The Finnish Research Infrastructure Committee has opted for a model in which its decisions are based on international peer review while the overall responsibility lies with the host organisation. This model has proved to be efficient in prioritising research infrastructures in a way that appropriately serves the needs of the scientific community and the Committee's strategic focal points. As a result, Finland has been able to join several distributed and virtual international research infrastructures during the strategy period. During the current four-year period, the Committee has recommended to the relevant ministries that Finland should seek membership in eight international research infrastructure networks. Through the FIRI funding calls, the Committee has, in addition to supporting high-level scientific research, encouraged infrastructures to openness in usage policies, systematic data management and broader cooperation between actors. Furthermore, the Committee has developed the open-access Finnish Research Infrastructure Database in cooperation with the Open Science and Research Initiative. (infras.openscience.fi)

In future, this categorisation will influence the content of FIRI applications and evaluation principles; very advanced infrastructures will be evaluated more lightly, while funding for advanced and monitored research infrastructures will be influenced by their advancement of the development targets identified in the review.

6 Abbreviations

AALTO	Aalto University
Aalto Ice Tank	Aalto University multi-purpose tank to research physical phenomena related to ice, ships and waves
AnaEE	Infrastructure for Analysis and Experimentation on Ecosystems
BBMRI	Biobanking and Biomolecular Resources Research Infrastructure
Biocenter Finland	Distributed national research infrastructure of five biocenters in six Finnish universities
BIOECONOMY	Bioeconomy Infrastructure
CERN	European Organization for Nuclear Research,
CESSDA	Consortium of European Social Science Data Archives
CLARIN	Common Language Resources and Technology Infrastructure
CSC	IT Center for Science Ltd
CTA	Cherenkov Telescope Array
DIPI	Digital Preservation Infrastructure
EATRIS	European Advanced Translational Research Infrastructure in Medicine
ECA	ELIXIR Consortium Agreement
EFDA-JET	Joint European Torus
EISCAT_3D	European Incoherent Scatter Facility, ISR radar system located in Kiruna, Sodankylä and Tromsø
ELIXIR	European Life Science Infrastructure for Biological Information
EMBC	European Molecular Biology Conference
EMBL	European Molecular Biology Laboratory
EOSC	European Open Science Cloud
EPOS	European Plate Observing System
ERIC	European Research Infrastructure Consortium
ESA	European Space Agency

ESFRI	European Strategy Forum on Research Infrastructures
ESO	European Southern Observatory
ESRF	European Synchrotron Radiation Facility
ESS	European Social Survey on developments in social values within Europe
EU	European Union
EuBI	Euro-BioImaging, European Research Infrastructure for biomedical imaging
EUCLID	ESA cosmological mission to study dark energy
EU-OPEN-SCREEN	European Infrastructure of Open Screening Platforms for Chemical Biology
Euro-Argo	Global Ocean Observing Infrastructure
FAIR	Facility for Antiproton and Ion Research
FGCI	Finnish Grid and Cloud Infrastructure
FinBIF	Finnish Biodiversity Info Facility
FIN-CLARIN	Finnish language resources and technology infrastructure, part of the international common language resources and technology infrastructure CLARIN ERIC
FinELib	National Electronic Library
FINMARI	Finnish Marine Research Infrastructure
Finna	Public Interface of the National Digital Library
FIRI	Finnish Research Infrastructure
FIRI-ATR	Finnish Research Infrastructure expert group (FIRI-ATR), which functioned between 2012–2014 as the predecessor of the Research Infrastructure Committee (Committee)
FIRI Committee	Finnish Research Infrastructure Committee
FMAS	Finnish Microdata Access Service
FP9	EU Framework Programme 9

GBIF	Global Biodiversity Information Facility
H2020	Horizon 2020, EU Research and Innovation Programme for 2014–2020
ICDP	International Continental, Scientific Drilling Program
ICOS	Integrated Carbon Observation System, a network of researchers and measurement stations measuring levels of greenhouse gases
ICT	Information and communications technology
IML	Mittag-Leffler Institute
INAR RI	Integrated Atmospheric and Earth System Science Research Infrastructure
INFRAFRONTIER	European Infrastructure for Phenotyping and Archiving of Model Mammalian Genomes (for the analysis, archiving and distribution of genetically modified mice)
InRoad	Synchronising research infrastructure roadmapping in Europe, H2020 project
Instruct	Integrated Structural Biology
IODP	Integrated Ocean Drilling Program
ITER	International Thermonuclear Experimental Reactor
JHR MTR	Jules Horowitz Materials Testing Reactor
JYFL-ACCLAB	Accelerator Laboratory of the Department of Physics at the University of Jyväskylä
KDK	National Digital Library
LVM	Ministry of Transport and Communications
MAX IV	Synchrotron radiation facility in Lund
NaPPI	National Plant Phenotyping Infrastructure
NeIC	Nordic eInfrastructure Collaboration Facility, part of Nordic e-Infrastructure Collaboration
NOT	Nordic Optical Telescope
NVVL	National Virus Vector Laboratory

oGIIR	Open spatial data research infrastructure
OKM	Ministry of Education, Science and Culture
OtaNano	Otaniemi micro- and nanotechnology research infrastructure
PAS	Solution for the long-term preservation of electronic materials
PRACE	Partnership for Advanced Computing in Europe
RAMI	RawMATTERS Infrastructure
STM	Ministry of Social Affairs and Health
TEM	Ministry of Employment and the Economy
THL	National Institute for Health and Welfare
TTA	National Research Data Initiative, an infrastructure which forms part of the national infrastructure services
TTA-KDK	The National Digital Library's PAS digitisation project
XBI	European X-ray Free-Electron Laser (XFEL) and its Integrated Biology Infrastructure (XBI)
XFEL	European X-ray Free-Electron Laser

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Appendices

Appendix 1. Evaluation criteria for national research infrastructures

National criteria for research infrastructures

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1 General evaluation criteria for research infrastructures

There are a set of general criteria for research infrastructures. A research infrastructure must:

- provide potential for world-class research and scientific breakthroughs
- be of broad national interest and enhance the international impact
- have a long-term plan for scientific goals, maintenance, financing and utilisation
- be used by several research groups/users for high-quality research
- be open and easily accessible for all researchers
- have a plan for access to and preservation of collected data and/or materials in spirit of open science and data policy.
- be extensive enough so that individual groups cannot manage them on their own
- introduce new cutting-edge technology (if relevant).

A research infrastructure can be national or international and single-sited, distributed or virtual.

The development of research infrastructures involves several phases, from ideas, concept development, and planning to construction and operation, to occasionally upgrading, and eventually to phasing out. These phases have different financing needs. To assure that long-term research infrastructure needs are met, different types of support and financing are necessary. From a research infrastructure perspective, relevant types of funding include:

- planning grants for design studies and planning of construction or collaboration
- grants for investing in equipment or databases, used to construct national or international research infrastructures or a single research infrastructure that is nationally accessible
- grants for operational costs of maintaining the operation in the long term
- grants for phasing-out the research infrastructure (when relevant)

A well-designed funding plan is important for the long-term design of a research infrastructure. The construction phase, mainly for centralised research infrastructures involving facilities and instrumentation, requires major, limited-time investment costs. The cost balance between construction and operation may be the opposite for distributed research infrastructures, where the greatest expense is seldom the investment cost, but rather the cost of ongoing work in standardisation, harmonisation and quality assurance of procedures and data.

Usually, research infrastructures must be upgraded to maintain their competitive strength, necessitating financing of new investments. Eventually, most research infrastructures will be phased out, which is associated with substantial costs of disassembling technical equipment and phasing out staff, etc. Hence, a phase-out plan should also be established prior to a decision to build a research infrastructure.

2 Specific evaluation criteria for research infrastructures

The research infrastructure projects evaluated maybe at different stages in terms of their life cycle. Some are in the planning phase while others might already be completely operational. For those research infrastructures that are in the planning phase, the evaluation is mainly based on anticipated future impacts rather than actual results. For existing research infrastructures the actual results will be evaluated.

The criteria used should be fair and equal, reflecting the international state of the art within the field in question. Major upgrades of existing research infrastructures or their reorientation require an evaluation of all criteria, the general and specific ones on pages 3 and 4-6, respectively.

The evaluation of the research infrastructures is carried out in a process comprising five different dimensions. Each research infrastructure is evaluated individually in each separate dimension as well as in comparison to the other infrastructures in all other areas of science. The dimensions are:

1. Scientific quality and potential
2. Open access and utilisation
3. Relevance to the strategies of host institutions
4. National and international relevance
5. Feasibility and Sustainability

2.1 Scientific quality and potential

The leading principle of evaluation is enabling scientific excellence through the research infrastructures.

Specifically, the following issues must be addressed:

1. The research infrastructure is of scientific significance, enables frontier research, is timely and provides added value at the national and international level
2. The research infrastructure is continuously used by excellent researchers and research groups
3. Existing research infrastructures shall provide an account of their activities, showing utilisation rate and impact, for example, in the form of publications and data methods
4. The research infrastructure participates in the training of researchers and students or is utilised for these purposes

2.2 Open access and utilisation, Finnish and international users

Research infrastructures have developed in many different ways. The use of research infrastructures has partly grown organically over time and partly been tailored to the specific research needs. In many cases, new research infrastructures attract excellent user groups from other disciplines as well as researchers from abroad.

1. There should be transnational open access to the research infrastructure. Access may require approval of a research plan and reasonable user fees as a compensation for the maintenance, user support and other services
2. The research infrastructure should have data policy that supports the Open Science concept in which research methods, data and outcomes are all thoroughly documented and publicly accessible in an open manner. Therefore, the research infrastructure must have a data management plan that consists of information on data acquisition, computation, storage, and ownership of the data
3. The research infrastructure must have clear and well-functioning leadership and administrative structures, adequate personnel for the maintenance, services and user support of the research infrastructure
4. The research infrastructure should monitor its utilisation rate
5. The research infrastructure should demonstrate its contribution to the training, e.g. provision of courses, professional guidance and science education

2.3 Strategic relevance of the research infrastructure for Finland

Building and operating a research infrastructure requires a long-term commitment from the research infrastructure itself and the host as well as other contributing institutions. Therefore, the strategies and priorities of the host institution(s) will also be included in the evaluation.

2.4 National and global relevance

This dimension of evaluation relates to the added value the research infrastructure provides for the national and/ global research community, and how it contributes to the visibility, global attractiveness and future development of Finnish research environment.

1. Strategic significance of the research infrastructure for Finland
2. Added value of research infrastructure:
 - for society, at large
 - for innovation activities, business and economy
 - through global cooperation (e.g mutual mobility) of Finnish research community

2.5 Feasibility and sustainability

The feasibility and sustainability of the project is assessed on the basis of the technical, institutional (e.g. form of ownership, terms of use or membership) and personnel requirements during the whole life cycle of the research infrastructure.

The expenses consist of planning, investment, operational and decommissioning costs during the whole life cycle of the research infrastructure.

Planning costs

Investment costs

- Construction/Building (incl. manpower)
- Acquisition of real estate
- Special technical equipment
- Supply/construction of devices and equipment

Operating costs

- Personnel costs (e.g. operation, maintenance, user support)
- Material costs (incl. membership fees or other payment of contributions to organisations)
- Costs of running the premises (rent, electricity)
- Other noteworthy investments (replacement purchases) required to keep the research infrastructure and equipment on an adequate level, reflecting the state-of-the-art

Decommissioning costs

- Costs of closing down the business and conservation of the resources developed

Ensuring sustainable funding during the whole life cycle of research infrastructure is essential not only for research infrastructure itself but also to the user community at large. In the financial plan investment and operational costs should be made explicit as well as the associated sources of those funds. Flexible business models are essential to keep research infrastructure sustainable in the long run.

For each research infrastructure call organised by the Academy of Finland, more detailed instructions for the costs covered are given.

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```
...
    _operation = "concat",
    mirror_sel.use_x = false
    mirror_sel.use_y = true
    mirror_sel.use_z = false
elif _operation == "concat_z":
    mirror_sel.use_x = false
    mirror_sel.use_y = false
    mirror_sel.use_z = true
...

```

