Ministry of Education

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Education

Research

National-level research infrastructures
PRESENT STATE AND ROADMAP
SUMMARY AND RECOMMENDATIONS

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NATIONAL-LEVEL RESEARCH INFRASTRUCTURES: PRESENT STATE AND ROADMAP

Summary and recommendations

Ministry of Education
Helsinki 2009

To the Ministry of Education

In 2006, ESFRI, the European Strategy Forum on Research Infrastructure published its plan, the so-called roadmap, on the needs to construct and update research infrastructures at the European level. Updating the ESFRI roadmap is currently under way. The EU's Competitiveness Council has recommended the preparation of national-level roadmaps to the Member States. The Research Infrastructure Committee appointed by the Finnish Ministry of Education proposed in its Report (Ministry of Education publications 2007:36) the mapping of national-level research infrastructures in Finland and the preparation of a roadmap of new needs. Statements received on the report noted the importance and urgency of mapping and preparing a roadmap.

The Ministry of Education granted funds to the Federation of Finnish Learned Societies for the mapping work and preparation of the roadmap during 2008. The Federation instituted a project for the purpose to which Senior Science Adviser Eeva Ikonen and Project Secretary Katri Mäkinen were appointed, along with Project Coordinator Marjut Nyman from 20 August to 19 November 2008.

The Ministry appointed a project Steering Group chaired by Counsellor of Education Mirja Arajärvi of the Ministry of Education. The invited members of the group were Director Mika Aalto of Tekes – The Finnish Funding Agency for Technology and Innovation, Professor Mikael Hildén of the Finnish Environment Institute, Professor Juhani Keinonen of the Federation of Finnish Learned Societies, Vice President (Research) Riitta Mustonen of the Academy of Finland, Senior Adviser, R&D, Martti Mäkelä of the Ministry of Transport and Communications, Counsellor of Education Marja-Liisa Niemi of the Ministry of Education, Head of Division Paula Nybergh of the Ministry of Employment and the Economy,

Chief Planning Officer Tuomas Parkkari of the Science and Technology Policy Council, Director of Research Mikko Peltonen of the Ministry of Agriculture and Forestry, and Director of Research and Development Kari Vinni of the Ministry of Social Affairs and Health.

Invited permanent experts of the Steering Group were Vice-Rector Outi Krause (Helsinki University of Technology) as a representative of the Finnish Council of University Rectors, Rector Tapio Varmola (Seinäjoki University of Applied Sciences) as a representative of the Rectors Conference of Finnish Universities of Applied Sciences, Secretary General Sari Löytökorpi of the Advisory Board for Sectoral Research, Adviser Janica Ylikarjula of the Confederation of Finnish Industries EK, and Programme Director Pekka Tolonen of the Finpro organization.

The secretary of the Steering Group was Senior Science Adviser Eeva Ikonen.

Owing to changes in professional tasks the Ministry of Employment and the Economy changed its representative to Director, Innovation Policy Sakari Immonen and the Finpro organization changed its representative to Programme Director Markus Ranne.

The Steering Group invited an independent national group of experts and three international panels of experts to evaluate the infrastructure proposals. The Steering Group held two public seminars for information and discussion during the process.

The Steering Group held nine meetings.

The Steering Group extends its warmest thanks to the staff and experts of the project and to the Federation of Finnish Learned Societies.

Helsinki, 2 December 2008

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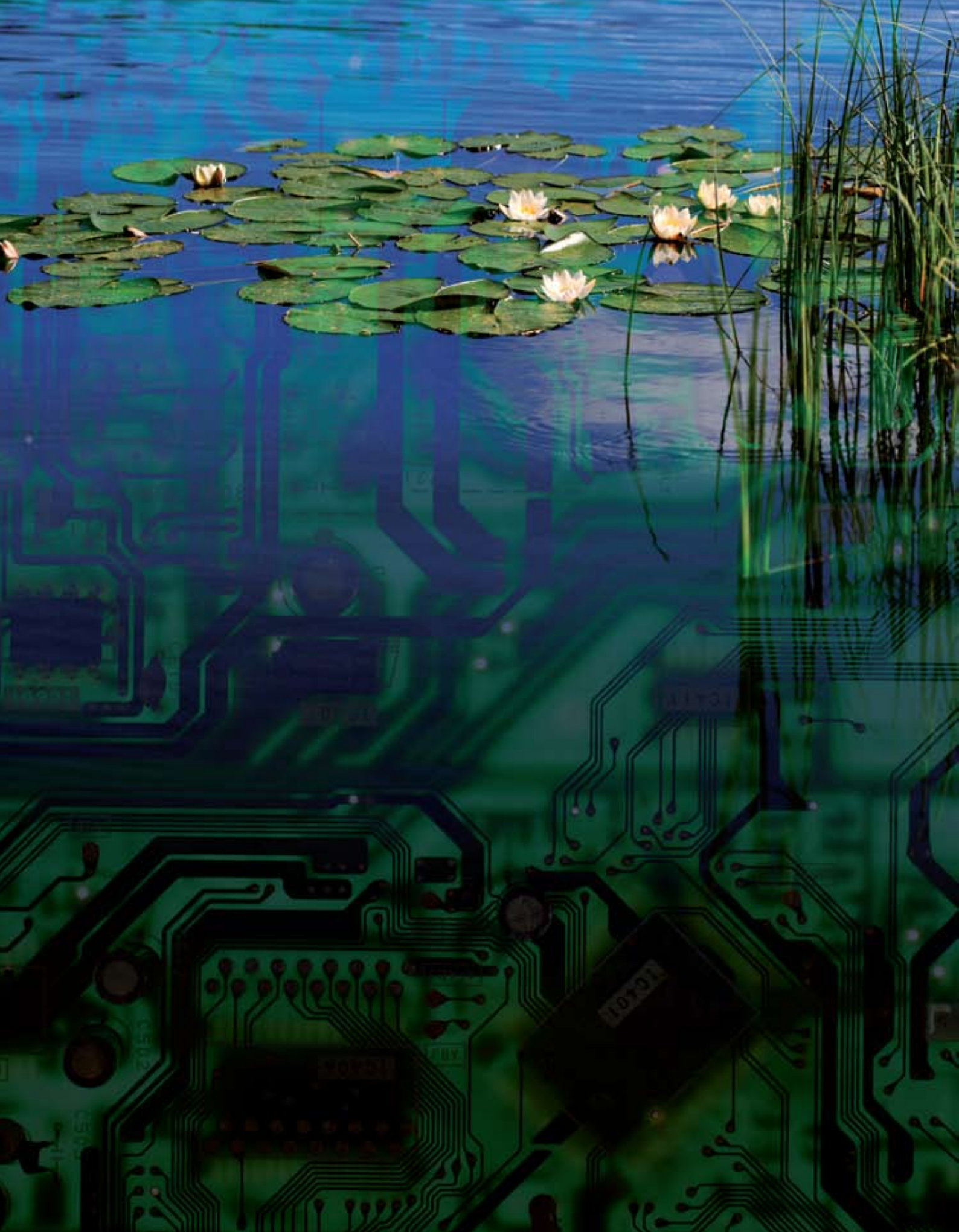


1. Introduction

Following the recommendation given in the Science and Technology Policy Council's report of 2006, the Finnish Ministry of Education in association with the Ministry of Trade and Industry appointed a Committee which was entrusted with the following tasks:

1. To draw up a proposal for procedures for identifying and evaluating the need for establishing significant new research infrastructures at the national level or for developing existing infrastructures, and for the procedures of prioritizing projects;
2. To prepare a proposal for a system for funding research infrastructures and for a division of tasks among financing parties, taking particular note of significant common infrastructures of several organizations or different sectors of administration as well as international infrastructures; and
3. To carry out a preliminary mapping in collaboration with the Research Councils of the Academy of Finland and Tekes of significant national research infrastructures and to make proposals on their renewal and development.

The purpose was to prepare a so-called national roadmap to be updated at intervals of 2–3 years concerning the infrastructures that will be needed over following 10–15 years with regard national needs and developments at the international level. The mapping work was noted to be such an extensive and time-consuming task that the Committee felt that it could not carry it out with its own resources. In a report presented in 2007, the Committee proposed that the national-level infrastructures and participation in international infrastructures were to be mapped and a roadmap of new needs was to be drawn up. This proposal was widely supported in related comments.

In January 2008, the mapping of national-level research infrastructures in Finland was launched, with funding from the Ministry of Education. On the 16th of January 2008, the Ministry appointed a Steering Group for this work, representing various sectors of administration, scientific and scholarly communities, funding parties, and the private sector. The mapping was carried out by the Federation of Finnish Learned Societies. In connection with the project various parties were able to make proposals regarding participation in present or future international infrastructures.

Research infrastructures (hereinafter infrastructures) are resources of research facilities, equipment, materials and services permitting research and development at different stages of innovation, supporting organized research, and maintaining and developing research capacity.

A single-sited research infrastructure is appropriate in fields requiring major investments in expensive research equipment. Single-sited infrastructure may include satellite units, and it may also permit remote use.

A distributed research infrastructure is suited to fields in which the available resources are geographically dispersed. A distributed infrastructure may also produce shared, centralized services.

Virtual research infrastructures are, for example, databases, archives etc. that can be used by researchers from their own workstations.

2. Research Infrastructures at the National Level and the Roadmap

The Steering Group has listed the following 24 projects as significant national-level infrastructures in Finland (Table 1 [1]):

- National Board of Antiquities (NBA)
- National Archives Service of Finland (NARC)
- The collections of the National Library (FNL)
- The National Electronic Library (FinElib)
- Finnish Social Science Data Archive (FSD)
- Finnish Information Centre for Register Research (ReTki)
- Archives and collections of linguistic corpora/Collections of electronic linguistic corpora (ACLC/CELC)
- Finnish Long-Term Socio-Ecological Research network (FinLTSER)
- Finnish Museum of Natural History (FMNH)
- Stations for Measuring forest Ecosystem - Atmosphere Relationships (SMEAR)
- The Pallas-Sodankylä Super Site (Pallas-Sod.)
- National Biobanks of Finland (FIMMDNA)
- Helsinki Functional Imaging Center (HFIC)
- National Virus Vector Laboratory (AIV Vector Core)
- Finnish Infrastructure Network for Structural Biology (NSB)
- Genome-wide and high-throughput methods, Biocenter Finland infrastructure network (GWHT)
- Finnish Genome Center (FIMM-FGC)
- Turku Bioimaging (BTI)
- Center for Systems Neuroimaging (NEUROIMAGING)
- Micronova Centre for Micro- and nanotechnology (Micronova)
- Low Temperature Laboratory (CRYOHALL)
- Accelerator Laboratory of the Department of Physics, University of Jyväskylä (JYFL-ACCLAB)
- Finnish University and Research Network (CSC-Funet)
- Services of the IT Centre for Science (CSC-Services)

1 Tables 1–4 are based on information supplied to the Steering Group by the parties making proposals.

Listed in Tables 2–3 are the international infrastructures in which Finland already participates and are significant for research. In addition, Finland has other significant international commitments that are important for research conducted in the country, international cooperation in other sectors and indirectly for political decision-making. Individual organizations may also have agreements with and memberships in infrastructures that were not charted here.

The Steering Group has accepted the following 20 proposals for the roadmap. Thirteen of them are associated with ESFRI's roadmap projects (Table 4):

- System Architecture for Memory Institutions
- Finnish Language Resource Consortium (FIN-CLARIN), ESFRI
- European Social Survey (ESS), ESFRI
- Council of European Social Science Data Archives (CESSDA), ESFRI
- Environmental Data System (EnviData)
- e-Science and technology infrastructure for biodiversity data and observatories (LIFEWATCH), ESFRI
- Finnish Long-Term Socio-Ecological Research Network (Fin LTSER)
- Environmental and Atmospheric Sciences: Integrated Carbon Observation System (ICOS), ESFRI, SMEAR Stations (SMEAR) and Pallas-Sodankylä
- The European Infrastructure for phenotyping and archiving of model mammalian genomes (Infrafrontier), ESFRI
- European Advanced Translational Research Infrastructure (EATRIS), ESFRI
- European Life Science Infrastructure for Biological Information (ELIXIR), ESFRI
- Biobanking and Biomolecular Resources Research Infrastructure (BBMRI), ESFRI
- National Virus Vector Laboratory (AIV Vector Core)
- Jules Horowitz Materials Testing Reactor (JHR MTR), ESFRI
- European Synchrotron Radiation Facility (ESRF), ESFRI
- Micronova Centre for Micro- and Nanotechnology (Micronova)
- Facility for Antiproton and Ion Research (FAIR), ESFRI
- Upgrade of Cryohall (CRYOHALL)
- CSC, Funet roadmap to the next decades (Funet), Finnish Grid Infrastructure for mid-range computing (FGI)
- Partnership for Advanced Computing in Europe (PRACE), ESFRI

The Steering Group maintains that decisions should be made as soon as possible concerning funding for the following seven national or international projects that have been accepted for the roadmap:

- Linguistic materials and technology
- Data archives in the social sciences
- Infrastructures of the environmental and atmospheric sciences
- Infrastructures of the biomedical and life sciences
- The renewal of European synchrotron radiation equipment
- European infrastructure for nuclear and particle physics
- Project entity of the IT Center for Science

These projects are linked to European research infrastructure projects, of which the planning stage has begun and the construction stage will take place in 2009–2011. Therefore, decisions are needed as soon as possible on Finnish commitment to infrastructures in these fields.

Table 1. Existing national research infrastructures, estimated operating costs in 2007, and numbers of users in 2007.

Existing national-level research infrastructures	Operating costs (2007) M€	Users (2007)
Social Sciences and Humanities	**63.0**	
National Board of Antiquities (NBA)	20.0	4,600
National Archives Service of Finland (NARC)	15.5	1,550
The collections of the National Library (NLF)	10.0	200,000
The National Electronic Library (FinElib)	16.1	415,000
Finnish Social Science Data Archive (FSD)	0.8	1,000
Finnish Information Centre for Register Research (ReTki)	0.2	10,000
Archives and Collections of Linguistic Corpora/Collections of Electronic Linguistic Corpora (ACLC/CELC)	0.4	1,500
Environmental Sciences	**20.2**	
Finnish Long-Term Socio-Ecological Research network (FinLTSER)	7.5	2,000
Finnish Museum of Natural History (FMNH)	7.0	550
Stations for Measuring forest Ecosystem - Atmosphere Relationships (SMEAR)	2.5	530
Pallas-Sodankylä Super Site (Pallas-Sod.)	3.2	320
Biomedical and Life Sciences	**20.7**	
National Biobanks of Finland (FIMMDNA)**	1.0	60
Helsinki Functional Imaging Center (HFIC)	2.8	730
National Virus Vector Laboratory (AIV Vector Core)*	0.5	80
Finnish Infrastructure Network for Structural Biology (NSB)*	3.0	550
Genome-wide and High-Throughput methods, BF infrastructure network (GWHT)*	1.8	510
Finnish Genome Center (FIMM-FGC)**	1.5	1,050
Turku Bioimaging (TBI)	8.5	400
Center for Systems Neuroimaging (NEUROIMAGING)	1.6	170
Materials Science and Analytics	**9.0**	
Micronova Centre for Micro- and nanotechnology (Micronova)	9.0	260
Physics and Technology	**3.7**	
Low Temperature Laboratory (CRYOHALL)	0.7	60
Accelerator Laboratory of the Department of Physics, University of Jyväskylä (JYFL-ACCLAB)	3.0	370
e-Infrastructures	**17.0**	
Finnish University and Research Network (CSC-Funet)	7.0	380,000
Services of the IT Centre for Science (CSC-Services)	10.0	3,050
Total	**133.6**	

*Biocenter Finland

**Collaboration agreement between Biocenter Finland and FIMM

Photo: Katri Mäkinen

Table 2. Finnish involvement in significant international infrastructures, membership fees in 2007 and year of affiliation.

International research infrastructure	Membership fee (2007) k€	Year of affiliation
Biomedical and Life Sciences		
European Molecular Biology Laboratory (EMBL)	1,100*	1984
Energy Research		
Joint European Torus (EFDA-JET)	93*	1995
International Thermonuclear Experimental Reactor (ITER)	26*	2007
Materials Science and Analytics		
MAX Synchrotron Radiation Facility (MAX-lab)	9	1991
European Synchrotron Radiation Facility (ESRF)	520	1989
Space Research and Astronomy		
European Space Agency (ESA)	14,300**	1995
European Southern Observatory (ESO)	1,900	2004
Nordic Optical Telescope (NOT)	439	1984
European Incoherent Scatter Association (EISCAT)	310	1983
Physics and Technology		
European Organization for Nuclear Research (CERN)	8,900	1991
Total	**27,597**	

*Membership fee in 2008

**Including membership fees, mandatory participation fees, technology programmes and Earth Observation Programme

Table 3. Other memberships in international research infrastructures, membership fees in 2007 and year of affiliation.

International research infrastructure	Membership fee (2007) k€	Year of affiliation
International Continental Scientific Drilling Program (ICDP)	23.7	2005
Integrated Ocean Drilling Program (IODP) / European Consortium for Ocean Research Drilling (ECORD)	52.5	1986
Global Biodiversity Information Facility (GBIF)	79.5	2003
European Social Survey (ESS)	240.0*	2003
The International Institute for Applied Systems Analysis (IIASA)	600.0	1976
International Neuroinformatics Coordination Facility	84.0	2005
Total	**1,079.7**	

* No membership fees, all the costs are operational.

Table 4. National-level research infrastructures for the roadmap, time of construction stage[2] and estimates of construction-stage costs and annual use costs for Finland.

Proposal for the Roadmap	Construction Stage	Construction Costs M€	Operational Costs M€/year	national/ ESFRI
Social Sciences and Humanities		**21.1**	**4.3**	
System Architecture for Memory Institutions	2008–2012	15.0	3.7	national
Finnish Language Resource Consortium (FIN-CLARIN)	2009–2020	5.0	0.2	ESFRI
European Social Survey (ESS)	2007 –	not existent	0.3	ESFRI
Council of European Social Science Data Archives (CESSDA)	2010–2014	1.1	0.1	ESFRI
Environmental Sciences		**24.1**	**9.4**	
Environmental Data System (EnviData)	2010–2011	1.0	0.5	national
LIFEWATCH and Fin LTSER	2010–2019	15.6	3.4	national/ESFRI
Environmental and Atmospheric Sciences	2009–2011	7.5	5.5	national/ESFRI
Biomedical and Life Sciences		**48.6**	**2.9**	
The European infrastructure for phenotyping and archiving of model mammalian genomes (Infrafrontier)*	2011–2014	5.1	0.4	ESFRI
European Advanced Translational Research Infrastructure (EATRIS)**	2010–2012	10.0	NA ***	ESFRI
European Life Science Infrastructure for Biological Information (ELIXIR)	2010–2013	16.5	1.0	ESFRI
Biobanking and Biomolecular Resources Research Infrastructure (BBMRI)**	2010–2013	17.0	1.0	ESFRI
National Virus Vector Laboratory (AIVVectorCore)*	2009–	not existent	0.5	national
Energy Research		**10.0**	**0.5**	
Jules Horowitz Materials Testing Reactor (JHR MTR)	2008–2014	10.0	0.5	ESFRI
Materials Science and Analytics		**44.6**	**4.06**	
European Synchrotron Radiation Facility (ESRF)	2008–2017	0.6	0.06	ESFRI
Micronova Centre for Micro- and nanotechnology (Micronova)	2009–2016	44.0	4.0	national
Physics and Technology		**8.2**	**1.6**	
Facility for Antiproton and Ion Research (FAIR)	2008–2017	5.5	0.8	ESFRI
Upgrade of cryohall (CRYOHALL)	2009–2012	2.7	0.8	national
e-Infrastructures		**73.0**	**9.7**	
CSC, Funet roadmap to the next decades (Funet), Finnish Grid Infrastructure for mid-range computing (FGI)	2009–2012	57.0	6.7	national
Partnership for Advanced Computing in Europe (PRACE)	2010–2013	16.0	3.0	ESFRI
Total		**229.6**	**32.5**	

* Biocenter Finland

** Collaboration agreement between Biocenter Finland and FIMM

*** NA=data not available

2 The lifespan of a research infrastructure can be divided into the following stages: planning, construction, use, further development and decommissioning.

In addition, the Steering Group identified from among the roadmap proposals the following 13 national or international proposals that could have possibilities to develop into significant national research infrastructures. This may require, among other factors, the merging of certain projects in order to reinforce the national infrastructure capacity of the fields in question. Projects having such potential are:

- Micro Data Remote Access System (MIDRAS)
- Upgrade of the Data Services of the Finnish Social Science Data Archive (FSD)
- Community heavy-Payload Long endurance Instrumented Aircraft for tropospheric research in Environmental and Geo-Sciences (COPAL), ESFRI
- A Finnish Integrated Network for Structural Biology (FinnStruct)
- Integrated Structural Biology Infrastructure Proposal (INSTRUCT), ESFRI
- Cluster of Biomedical Imaging (TBI&NEUROIMAGING&BIU)
- Geoinformatics Research Infrastructure Network (GRIN)
- Finnish Stem Cell Bank (FinnStem)
- European Extremely Large Telescope (E-ELT), ESFRI
- MAX IV synchrotron and free electron laser facility
- Infrastructure of processing biomaterials (BIOMATINFRA)
- Metsähovi Radio Observatory (MRO-2: Building Finnish Radio Astronomy's Future)
- European next generation Incoherent Scatter Radar (EISCAT_3D), ESFRI

3. Criteria and Procedure for Choosing Research Infrastructures

The project for mapping national-level research infrastructures in Finland was launched in February 2008 with a seminar aimed at involved groups on the theme of "Finland and European research infrastructure projects". The seminar featured presentations on Finnish interest in participating in European research infrastructure projects taken up by ESFRI, and the launched national mapping work was also presented.

The mapping of national-level research infrastructures and new infrastructure needs was carried out through an open Internet survey. The survey was open to participants during the spring for a period of over one month.

Preliminary notification of the survey was sent to a large target group consisting of universities, polytechnics, archives, and public and private research institutions, among other bodies. It was also possible to respond to the survey without separate invitation. A total of 297 proposals were received, 116 of which were for the national roadmap.

The Steering Group laid down the criteria listed below for the infrastructures of the national level. The respondents to the survey were to take into account these criteria of national-level infrastructure, which were issued beforehand.

Fulfilment of most of the following criteria is required of national-level infrastructure and plans for the roadmap:

1. Demonstrable administrative structures and responsible personnel for the upkeep and services of the infrastructure;
2. An annual report or similar account of the infrastructure's activities showing its degree of use and effectiveness, for example in the form of scientific output, new applications, patents, new products or generated business activities;
3. The infrastructure participates in the training of researchers or is utilized for these purposes;
4. The research infrastructure is of scientific significance and its work provides added value at the national or international level;
5. The infrastructure is continuously used by a significant number of Finnish or foreign researchers;
6. The infrastructure provides its users with services for its utilization;
7. In principle free access for utilization of the infrastructure. This, however, may require approval of a research plan and reasonable compensation for user fees, guidance and services;
8. The investment costs of the infrastructure in question are relatively high in comparison with other infrastructures in the same field;
9. The annual budget of the infrastructure is relatively high in comparison with other infrastructures in the same field;
10. The infrastructure has added value in industrial-commercial terms or for the common good either in the short (e.g. construction stage) or long term (e.g. utilization of results).

In addition, the following points were to be elucidated with regard to participation in an existing international research infrastructure:

1. The scientific significance of the infrastructure for Finland;
2. Other utilization of the infrastructure in Finland;
3. Annual membership fees payable by Finnish parties;
4. User fees payable by Finnish researchers for the utilization of the infrastructure;
5. The degree to which Finnish researchers utilize the infrastructure;
6. The participation of Finnish doctoral students in courses and professional guidance provided by the infrastructure.

Owing to the large number of replies, their overlap and uneven quality, the Steering Group invited an independent national group of experts to evaluate which projects met the minimum criteria of projects at the national level. Based on the proposals of the expert group, the Steering Group chose the project proposals that could be evaluated by the three International Expert Panels appointed by the Steering Group.

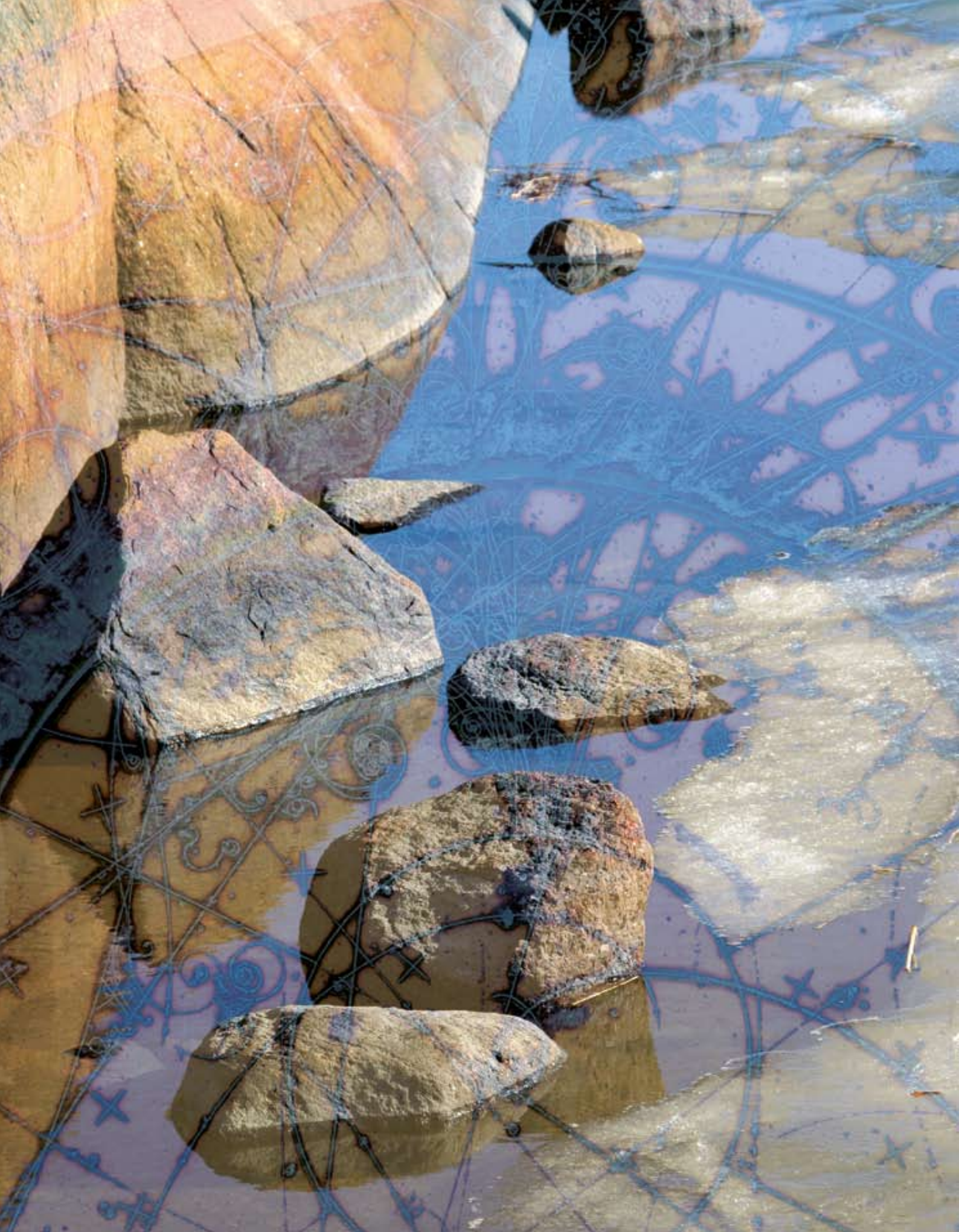
Many of the proposals overlapped, or the projects were of local nature. There could also be parallel proposals of a single project for the roadmap or for the list of existing national-level infrastructures. The International Expert Panel also recommended that the units operating at the Helsinki Biomedicum should collaborate in drawing up only a few joint proposals. A similar recommendation was given concerning the units of the Biocenter at Viikki in Helsinki. The roadmap list contains several projects that can be regarded as falling under the cooperation agreement between Biocenter Finland and Finnish Institute of Molecular Medicine.

The Steering Group invited three International Expert Panels:

- Life Sciences & Medicine and Environmental sciences - LME,
- Physical Sciences, e-Science and Engineering - PSE, and
- Social Sciences and Humanities - SSH.

In late July 2008 the Secretariat sent the selected project proposals to be evaluated by the Panels. The International Expert Panels met in September 2008, each of them spending three working days in Finland. A total of 61 hearings were held at this time. After a joint decision, a statement was written of each project. In addition to evaluations of specific projects, each Panel prepared a final report containing general recommendations and the results of evaluation.

The recommendations of the International Expert Panels were addressed at an information and feedback seminar held in October 2008, to which large numbers of the parties involved in the mapping were invited. The discussions in which the participants engaged and subsequent feedback were taken into account in drawing up the proposals.



4. Recommendations for Specific Fields of Research

4.1. General Remarks

In many fields Finland has unique registers, bodies of material and collections that could be the basis of strong research infrastructures serving a wide body of users. The results of research and information resources in numerous fields are utilized by other actors in society than the scientists and scholars of the fields concerned.

Recommendation 1. The usability of national registers and the availability of materials should be improved and costs to the user should be reduced, where necessary by amending related legislation. Valuable bodies of material collected in Finland should be made available for broader international use by increased digitization of materials and by implementing uniform collection procedures in accordance with international standards.

An urgent task at present is to digitize materials of importance for research and to ensure the preservation of original materials for efficient utilization by future generations. The availability of information resources, their user-friendliness and shared use should be subjects of particular attention in all fields. In practice, this means the development of material (data) policies in a more open direction than previously, the minimization of fee-based use of national bodies of material, increased mobility of researchers and receiving researchers from other countries. The high standard of mobility services and reception of foreign researchers can help promote the European infrastructures to be located in Finland.

The growing amount of information and materials, and the development of information technology and methods for the management of materials have revolutionized research work in almost all fields. As a result, the importance of the so-called e-infrastructure has also grown.

Recommendation 2. Finland requires a shared vision of the kind of e-infrastructure that will best serve excellent research.

The operating concepts of certain sectoral research institutes and separate institutes are largely based on the utilization of a wide range of research facilities and field observation networks and/or the creation and upkeep of comprehensive databases. These are to be found in agriculture and forestry, among other fields. In the present mapping work, however, whole research institutes have not been regarded as research infrastructures, although they provide services necessary for society and produce and preserve materials of importance for research. A further requirement of national-level research infrastructure is free access for researchers to utilize materials. The condition is not met, or cannot be met, for example for security reasons in many separate institutions that are necessary for society.

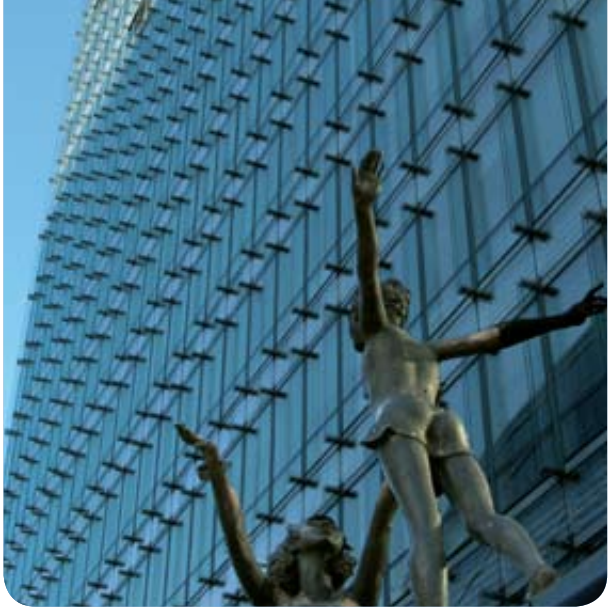


Photo: Katri Mäkinen

Photo: Eeva Ikonen

4.2. Social Sciences and Humanities

Entities consisting of memory institutions, materials related to the social sciences and linguistic materials can be indicated in the social sciences and the humanities. According to the International Expert Panel, the proposals are in many cases incomplete and poorly arranged as infrastructures of the national level.

Recommendation 3. Resources in the social sciences and the humanities should be concentrated and free access for researchers should be promoted for the utilization of valuable materials.

The development of infrastructure services may considerably expand the bodies of their users in this field from their present extent.

Recommendation 4. The consolidation of cooperation among memory institutions[3] that has been instituted with support from the Ministry of Education is to be continued. The core material of the cultural heritage is to be digitized.

4.3. Environmental Sciences

Like the other Nordic countries, Finland devotes significant resources and effort into the environmental sciences. Finland has unique long-term bodies of material and high-standard observation stations serving environmental research. Especially in the atmospheric sciences and in the ecosystem studies discussion aiming at increased cooperation has already begun in Finland, as well as the organization of researcher groups, which serves the identification of the needs of national-level infrastructures and related planning.

Recommendation 5. By pooling resources and through the further development of research infrastructures Finland should seek a leading international role in the fields of environmental sciences in which it already has solid national expertise, significant data resources and research infrastructure.

3 The term memory institutions or organization applies to museums, archives and libraries

Photos: Rodeo

4.4. Biomedical and Life Sciences

According to the International Expert Panel, Finland has numerous strong areas in the biomedical and life sciences. The country has the opportunity to be a host to or have a leading role in some new European research infrastructures.

The biomedical and life sciences typically have a very large group of users, and the infrastructures of these fields are of major impact on society. In many cases research has direct applications in work with patients and preventive health care. The International Expert Panel felt that the biomedical and life sciences sector should focus more on the commercialisation of results. Research is making increasing use of resources of information that require a developed e-infrastructure and the services that it offers.

The biocentres of six Finnish universities have established the Biocenter Finland cooperation network coordinating the infrastructures of the centres and their use. For the time being, however, coordination has been insufficient. This was also evident in the fact that these universities submitted a large number of proposals that had not been assembled into national-level research infrastructures.

Recommendation 6. Biocenter Finland should use its position and responsibility for coordination in developing national-level research infrastructures.

4.5. Energy

Europe is seeking to adopt energy production in accordance with sustainable development. In order to achieve its set goals in combating climate change and in energy production, Europe needs to invest in research in renewable non-emission energy and technological development work in association with industry.

In Finland a significant portion of electricity is produced with nuclear energy, the production capacity of which may increase markedly. The safe and reliable use of nuclear energy and maintained skills require that we have the use of research and testing facilities needed to support of research and development of technology, either in Finland or elsewhere, and of other technological infrastructure. As a member of the EU, Finland is also involved in the ITER project for the construction of the next-generation fusion test reactor, which will require considerable funding from the EU Member States and other participating countries over the decades to come.

Finland is expected to participate in combating climate change and in international research and development in energy production that is required for sustainable development.

Recommendation 7. Finland is to ensure a broad scale of expertise and research in the energy sector, investments in research and development in renewable and non-emissive energy as required by involvement in international cooperation, and the utilization of international research infrastructures.

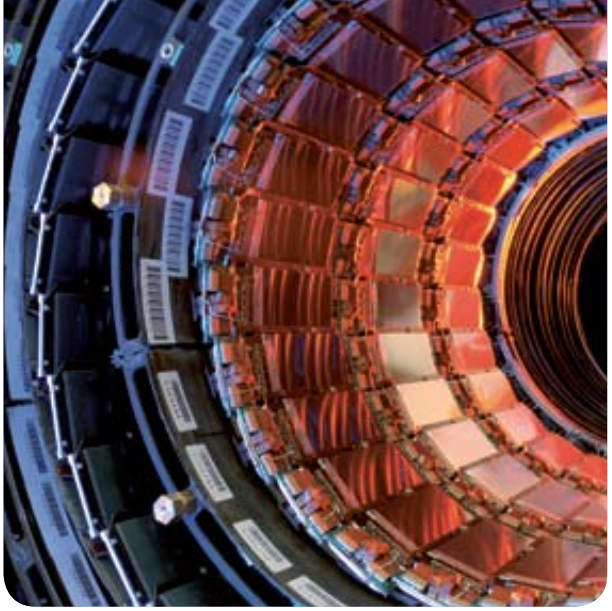


Photo: CERN

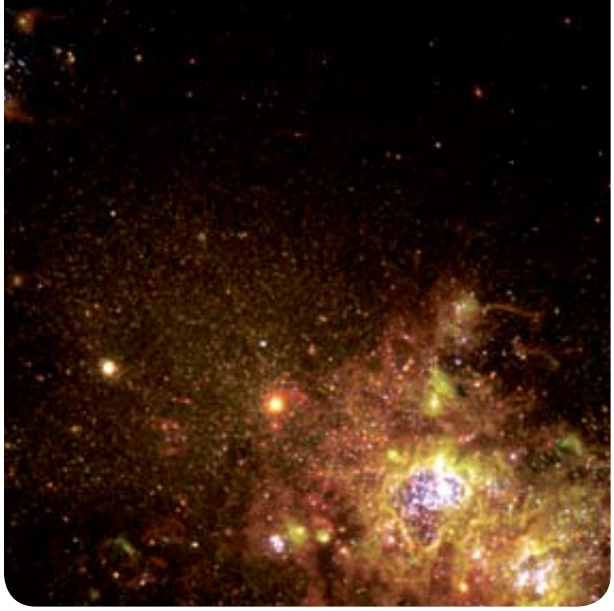


Photo: Rodeo

4.6. Materials Science and Analytics

Finland is a member of the Nordic consortium of the European Synchrotron Facility (ESRF), located in Grenoble. Synchrotron radiation is used in multidisciplinary studies of materials. For example, a significant proportion of the users of the ESRF are representatives of the biosciences. Finland has also made use of the Swedish Max Laboratory in Lund through a bilateral agreement since 1991.

Recommendation 8. Extensive multi- and cross-disciplinary research conducted with the aid of synchrotron radiation should be developed on the basis of nationally coordinated cooperation.

The applications of nanoscience and nanotechnology are rapidly expanding from electronics and new materials to the bio sector. At the same time, however, requirements for evaluating the security risks of applications are growing. Therefore, broad collaboration among different researchers is necessary in research in this field. Nano-level research requires high-standard clean rooms and special laboratories, which are worth concentrating in larger units.

Recommendation 9. Finland is to reinforce national coordination and division of tasks in nanoscience and nanotechnology and the utilization of international research infrastructures.

4.7. Space Research and Astronomy

European Space Research and astronomy have influenced related research in Finland through the international cooperation of Finnish researchers and later through memberships in the ESA and ESO organizations. Challenges of research policy for the Finnish scientific community are how to benefit as much as possible from existing memberships, and the kinds of infrastructures needed in Finland for utilizing international memberships.

Recommendation 10. The Finnish scientific community should draw up a joint plan for a project to develop astronomy, including existing national and international infrastructures and their utilization.

Photo: CERN

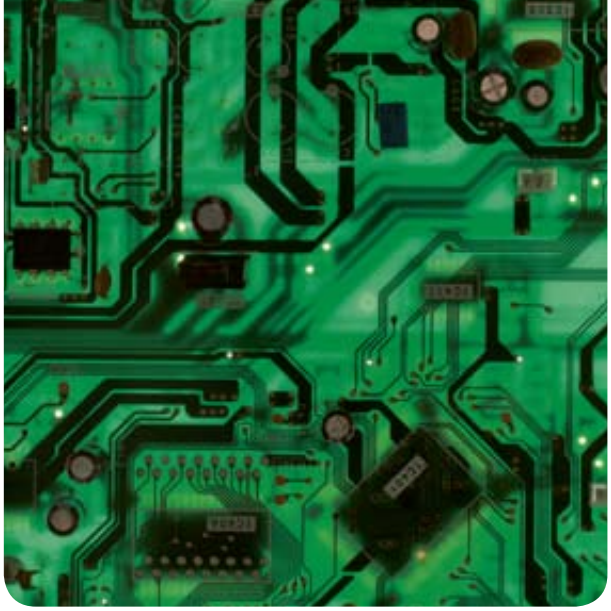


Photo: Rodeo

4.8. Physics and Technology

Large infrastructures are necessary for solving scientific problems in physics. On their own, small countries such as Finland, and most other countries as well, have very limited opportunities to host major research arrangements and infrastructures at the international level. Finland is involved in some significant infrastructures in support of research in physics (Table 2). The most important international research institute in Physics is CERN. The organization of Finnish activity related to CERN is a good example of national support for the wide use of an international research organization.

Recommendation 11. In order to maximize research carried out in major international infrastructures and related benefits, Finland needs to attend to domestic research infrastructures that support this work.

Infrastructures or arrangements of this kind include test laboratories, laboratories of instrument technology, theoretical research, graduate schools, training for experts and for international tasks, and cooperation with industry.

Research infrastructures in physics typically serve many other fields, an example being the above-mentioned ESRF. The infrastructures of physics also serve the development of technology, as in Information technology, instrumentation and material technologies.

4.9. Information Technology and e-Infrastructures

A considerable challenge for large research infrastructures consists of the management and storage of produced information and making it available to researchers in a user-friendly manner. This calls for good information management, centralized services, grid environments and a well-functioning information network. Resources that are distributed and planned well are a major challenge for e-infrastructures.

In Finland the CSC centre provides scientific computational services for universities and research institutes, maintains and develops an IT network for science, and is in charge of storage, maintenance and user support for large bodies of material in some fields of research. These tasks are of core importance for science in Finland. CSC is also prominently involved in Nordic and European cooperation to develop data networks, scientific computing and the use of data.

CSC submitted several project-type proposals to the national survey. The International Expert Panel recommended the creation of a national e-infrastructure strategy with CSC as its main actor.

Recommendation 12. The main tasks of CSC should be scientific computing services, IT network services and services related to the storage and use of large bodies of data. The work should be expanded towards increased service also for research institutions. CSC should continue its work of developing infrastructures in collaboration with users and parties producing information.

5. Conclusions and General Recommendations

The concept of national-level infrastructure needs to be clarified among scientific and scholarly communities. The quality of conducted research or the excellence of infrastructure as such do not yet indicate an infrastructure of the national level. The infrastructure also has to provide opportunities for use and service for users beyond its own organization, and outside use has to be of a significant degree. The use of infrastructure in many different disciplines, multidisciplinary projects and problem-based approaches is to be promoted.

5.1. Forming Infrastructure Entities and More Efficient Use of Infrastructures

The mapping of nationally significant infrastructures and the preparation of the roadmap pointed to a definite need to reinforce the international aspects of the Finnish research system and to assemble the dispersed infrastructure into national-level infrastructures serving a broader scientific community. In the future the research community is required to engage in closer cooperation and joint strategic planning.

Recommendation 13. The scientific community should be organized to prepare developed plans and for more efficient utilization of existing research infrastructures. This concerns infrastructures at both the national and local levels.

Recommendation 14. Cooperation in constructing and using infrastructures is to be improved among units of the same field and especially by establishing multidisciplinary infrastructure entities focusing on research in specific problem areas.

Actors noted as infrastructures of the national level, core groups chosen for the roadmap or those that have gained a position in them are to be regarded mainly as bearers of responsibility for cooperation. This role as such does not entitle funding. The quality and opportunities of a national infrastructure depend on the cooperation of all parties concerned.

For a small country such as Finland it is essential to maintain research infrastructures of the national level and to develop new ones through extensive cooperation between the public and private sectors.

In practice, the joint use of research infrastructures will lead to at least some degree of increased mobility for researchers, as well as receiving researches from other countries. Universities and research institutions need to improve services for mobile researchers. Services are generally one of the factors influencing the criteria of placement for European infrastructures.

Parties responsible for infrastructures should also take into account communications and international visibility. This work can utilize existing European services and the scientific community's own channels of communication.

5.2. Finnish Participation in International Research Infrastructures and ESFRI projects

Membership in central international infrastructures is often necessary for carrying out high-standard research. The other services improving conditions for research that are provided by infrastructures are also an important factor.

The efficient use of international infrastructures requires good national coordination. This has to encompass not only research as such but researcher training, information on science, utilization of results and any technological development and corporate cooperation association with developing the infrastructure.

The goals of internationalization require the development of critical mass and the creation of infrastructures in Finland that offer broader services. Strong, wide-ranging national infrastructures could be a way towards international recognition and attraction. Finnish researchers need to participate more than at present in coordinating and ambitious roles in the infrastructure schemes of EU Framework Programmes. The projects of the ESFRI roadmap provide important opportunities to operate at a national level as hosts for realizing jointly agreed plans or as the host of a unit of a dispersed international infrastructure. Finnish researchers have been actively involved in the preparation of several ESFRI projects.

Recommendation 15. Finnish researchers and experts should seek positions of responsibility in international research infrastructures in the fields in which there is significant Finnish expertise.

Finland is involved in several international and multinational infrastructure projects and programmes (Tables 2–3). Their total membership and participation fees amount to approximately €30 million per year. In addition to membership fees costs also arise from participation in the construction of infrastructures, in earlier investments, the work of administrative bodies and the mandatory or voluntary programmes of the organizations. Earlier investments can also be compensated through in-kind contributions.

Recommendation 16. International investments should aim at employing in-kind contributions, which promotes the development of domestic skills and cooperation with the corporate sector.

Research carried out in Finland, the development of technologies and cooperation with the business community or those who utilize the results are important in many fields. Finland's activity in CERN is a good example of the wide-ranging utilization of a large international research infrastructure.

Recommendation 17. Finnish research organizations should make better use of membership in international research infrastructures. Existing international commitments and research infrastructures at the national level should be utilized efficiently for the mobility of researchers, researcher training and the planning of the work of researcher training schemes.

Nordic consortiums have already provided good experiences in the case of some infrastructures. With regard to Finland, it is to be hoped that of the new international infrastructures, at least some significant entities or head offices would be located in the Nordic countries or regions near Finland.

Recommendation 18. In preparations for very large and expensive international projects joint arrangements for example with other Nordic countries should be considered.

5.3. Funding

According to the preliminary estimate provided by the present mapping, Finland spends approximately €130 million per year in public appropriations for the upkeep of the national infrastructures presented in Table 1. Finland uses some €30 million of public funds annually for the membership fees of international infrastructures (Tables 2 and 3). In addition to membership fees there can be other costs of membership both abroad and in Finland. As noted by the International Expert Panels in their recommendations,

participation in major international projects requires investment and the coordination of activity also at the national level for the most efficient utilization possible of international infrastructure.

The construction costs of the projects chosen for the roadmap will be approximately €230 million over the period 2008–2020, with annual costs for Finland approximately €30 million (Table 4). The schedule for implementing the projects and the focus of funding needs are highly different in different fields, which means that a funding instrument is needed for directing funding to projects on the basis of detailed funding proposals and plans.

Finland needs a centralized funding system for renewing the existing research infrastructures and for funding new projects at the national level. The centralized funding system should also take into account the needs for managing research infrastructure policy and the preparation of long-term international commitments. The Steering Group estimates that already in 2009 approximately €9 million will be needed to promote the most urgent projects. Between 2010 and 2016 over €200 million will be needed as a whole for carrying out the most urgent projects. This rough estimate partly includes use-related costs.

Recommendation 19. The development of national-level research infrastructures and research carried out in new international research infrastructures are to be supported with an additional appropriation in keeping with the needs for developing research and international cooperation in research.

Recommendation 20. The funding of infrastructures should be increased as part of the funding of universities and research institutions and on a centralized basis as competed funding for national-level infrastructures. In addition, there is a need to preparation for the membership fees of international infrastructures and the coordination of related national activities.

5.4. Research Infrastructure Policy

Research infrastructure policy should be an integral part of research and innovation policies. We need a national process for infrastructure policy. It needs to include all actors, from researchers to decision-makers in research and innovation policy. The importance of dialogue is emphasized when seeking joint synergy benefits. The reports of the two earlier working groups on these matters propose the founding of a permanent body with sound resources for the preparation and implementation of research infrastructure policy. These proposals have received support in statements given on the reports.

Recommendation 21. Research infrastructure policy should be an integral part of research and innovation policy and it should be implemented according to a consistent and well-planned model of action. For the purposes of implementation a research infrastructure council needs to be founded with ensured operating conditions, including a permanent secretariat.

The tasks of the body would include the preparation of strategy, follow-up, evaluation and the coordination of international participation. The work would also include reports on infrastructure, statements, the updating of the roadmap, preparation of funding decisions and to some degree funding decisions. The infrastructure council could also make proposals for solutions in the case of two or several competing coordinating bodies at the national level. These demanding and extensive tasks require permanent structures and personnel with expertise.

Recommendation 22. The purpose of the infrastructure council is to compile the views of researcher communities and other actors regarding the future needs of national-level research infrastructures and to arrange the evaluation of project proposals, taking into account the needs of society and the economy and to draw up plans for the realization of infrastructures on the basis of evaluations.

Recommendation 23. The national-level roadmap is to be evaluated on a continuous basis and updated at approximately 3-year intervals.

The planning of the schedule for the national roadmap requires accommodation to the European roadmap project. Applications for the funding of infrastructures and related decision-making should proceed apace with the European ESFRI project. Solutions

Photo: Eeva Kunen

and decision of even a quick nature will be needed with regard to the present ESFRI roadmap projects.

The various levels (local, national, international) and types (single-sited, distributed, virtual) of infrastructure should be taken into account in planning and organizing funding. New infrastructure needs at the national level may also emerge in the areas of so-called Strategic Centres for Science, Technology and Innovation (SHOK). It is therefore important to provide critical reviews and plans specific to disciplines to develop infrastructures or plans for a different kind of closer cooperation following the nature of the field in question.

Recommendation 24. Universities, research institutions and other maintaining bodies should take into account research infrastructures as part of their own strategy work. It should include the upkeep of existing infrastructures, improved joint use, new infrastructure needs, and a plan for funding. The planning should take into account situations where closer networking is more efficient than the implementation of a new infrastructure.

Recommendation 25. Ministries, parties funding research and the host organizations of infrastructures should prepare their own long-term plans for the use, development and funding of their infrastructures.

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