



Future research infrastructures

– needs survey and strategy proposal



Danish Research Agency

Ministry of Science,
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Danish Council for Strategic Research



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Research infrastructures are important tools for the research community. They are used in all fields of research from the social sciences through astronomy to genomics and nanotechnology.

Research infrastructures might, for instance, be libraries, databases, biological collections, cleanroom facilities, communications networks, research vessels, satellite and aircraft observation facilities, coastal observation stations, telescopes, synchrotrons, accelerators, etc.

Research infrastructures can be situated in one or more locations or they can be virtual.

“The ability of the Danish research community to maintain a leading position, to attract and retain the best partners and researchers as well as to contribute to economic growth and favourable societal progress depends on access to the most advanced infrastructures.”

The Danish Ministry of Science, Technology and Innovation wrote these words to the Danish Council for Strategic Research in 2004 when it asked the Council to survey existing research infrastructures – both national and international – as well as the scope of and need for updating. Furthermore, the Council was asked to give an assessment of the need for access to new national and international research infrastructures and to propose a Danish strategy for the area. It was emphasised that the survey should concentrate on research infrastructures on a scale that is beyond the means of individual institutions to procure.

This report, which was prepared by a taskforce* appointed by the Danish Council for Strategic Research, thus, presents the need for updating of and new investments in research infrastructures. The need has been assessed on the basis of a survey conducted by the taskforce in the course of 2005. The survey resulted in the following conclusions:

- there is an immediate need for investment in the upgrading of existing research infrastructures in the order of DKK 300 million.
- there is a need for investment in new national research infrastructures in the order of at least DKK 2 billion over the next 8-10 years.

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- there is a need for a significant increase in funding for participation in new international research infrastructures over the next 8-10 years.

This report highlights a number of examples of such needs for intra-disciplinary and inter-disciplinary infrastructures. In addition, the report proposes that investigation be instituted as soon as possible with regard to 1) the ability of libraries to serve researchers; 2) the need for funding to cover the costs of digitising scientific material and 3) the need for the coordination and financing of registers and databases.

The Danish Council for Strategic Research proposes that the substantial funding which is necessary be allocated via an action plan for investment in major national and international infrastructures. Proposals for the establishment of or participation in research infrastructures could be submitted using the template included in this report, and proposals could be incorporated into the action plan on the basis of a positive assessment.

The preparation of the action plan and the allocation of funding should take place within the research council system and it should be a transparent process involving all parties. In connection with revision of the action plan, current participation in international research infrastructures should be assessed and it should be determined whether participation should continue or whether withdrawal from the infrastructure should be included in the action plan.

In addition to this brief report, a background report has been prepared with comprehensive appendices. The material may be seen in its entirety (in Danish only) at www.forsk.dk or at www.forskninginfrastruktur.dk.

The Danish Council for Strategic Research – December 2005
Peter Elvekjær
Chairman of the Board

2 Methodology and delineation



The aim of surveying the existing research infrastructures in Denmark was, in part, to ascertain the scope of the different types of intra-disciplinary and inter-disciplinary infrastructures in use and, in part, to shed light on the different needs associated with the use of and collaboration regarding these research infrastructures. This broad and complex picture has formed the basis for a consolidated strategy in the area.

Previous surveys have indicated a need for investment in costly scientific equipment for natural and technical science research. The present survey covers all scientific areas, and a key prerequisite has been that it should also cover the Danish needs for access to international research infrastructures.

The present survey only covers major research infrastructures, i.e. research infrastructures that are unique in their scientific fields and that are of national and/or international importance, and thus have a significant number of external users. Furthermore, there will be a substantial need for investments by research institutions and research teams in order to maintain and replace instruments, facilities, databases, etc. at the local level, which the consolidated strategy proposed here is not geared towards.

The purpose of the survey was threefold:

- To survey existing major research infrastructures.
- To identify the need for upgrading existing major research infrastructures.
- To identify the need for investment in the establishment of new major research infrastructures as well as the need for financing Danish participation in new international research infrastructures.

The work has been conducted by a taskforce appointed by the Danish Council for Strategic Research. As part of the open process, a special website (in Danish only) was set up for the purpose (www.forskningsinfrastruktur.dk), which has been



regularly updated throughout the survey. The preliminary findings of the survey were also discussed at a conference in Copenhagen, May 2005.

As part of the survey, public research institutions, Authorised Technological Service Institutes (GTS institutes) and large companies were contacted, and all researchers have had the opportunity to provide input via the website. The taskforce received 279 responses to questionnaires on existing research infrastructures and future needs. The scientific research councils also contributed useful input to the survey.

To be included in the survey, the existing research infrastructures in natural science and technical research as well as in agricultural research had to have procurement costs totalling at least DKK 5 million, while in health science research, the procurement costs had to total at least DKK 15 million. In addition, there were requirements regarding the number of external users, etc. In the case of registers and databases, which are used especially in the social and health sciences, there had to be a minimum of three employees/man-years attached to the operation of the facility in question

3 Need for investment in research infrastructures



The survey has revealed that the existing major national research infrastructures are valued at approximately DKK 2 billion and that, in recent years, approximately DKK 300 million has been allocated through government grants to Danish participation in international research infrastructures.

For the implementation of an action plan for investment in research infrastructures, the Council recommends that the necessary funding be earmarked for: 1) upgrading existing research infrastructures; 2) establishing new national research infrastructures; and 3) Danish participation in new international research infrastructures. The action plan should be adjusted according to the results of the three investigations regarding research libraries, digitisation and registers and databases, which the Council proposes be initiated immediately.

Upgrading of existing research infrastructures

The survey has revealed an overall need for upgrading existing research infrastructures amounting to an immediate investment of approximately DKK 300 million. This is a short-term needs assessment. For a large proportion of the identified research infrastructures, no report was made as to the need for updating and upgrading, so realistically this figure is probably somewhat higher.

Investment in new research infrastructures

The survey has found an overall interest in establishing new major Danish research infrastructures amounting to approximately DKK 2 billion. However, it should be noted that investment in very large-scale projects has a long-term and erratic investment profile.

The cumulative figure of approximately DKK 2 billion covers substantial variation between disciplines and the various types of research infrastructure. Further, the many expressions of interest are formulated differently, from rough sketches of ideas to detailed project proposals, complete with budgets. Consequently, this is a general assessment of the many proposals submitted for



the establishment of new research infrastructures. However, it is also a minimum estimate of the investments required to ensure the necessary expansion of the research infrastructures. The rate of utilisation of existing, extremely costly equipment should be assessed on a regular basis.

The following examples, from among the many excellent proposals submitted during the survey, bear mentioning as being highly relevant within a short timeframe.

Establishment of the synchrotron radiation facility ASTRID 2000

The construction of a new synchrotron radiation facility ASTRID 2000, to replace the almost 15-year-old ASTRID facility, would deliver low-energy synchrotron radiation with high brilliance. The facility would fill a niche in Europe, as practically all other sources focus on hard synchrotron radiation. A new accelerator facility would ensure a strong accelerator environment, benefiting Danish public-sector and industrial research and innovation, stimulating the interest of young Danish students and attracting international experts and researchers who specialise in accelerator technology. The establishment costs for such a facility are estimated to be approximately DKK 25 million.

Increased investments in supercomputing and grid computing, including expansion of the research network

There is a need for greater investment in research in grid computing and in scientific computer equipment, including expansion of the PhD programmes in the various relevant fields of research, e.g. biotechnology and nanotechnology. More specifically, there is a need for increased and more long-term funding for the Danish Centre for Grid Computing (DCGC). Further, there is a need for a significant new investment of DKK 37.5 million in the basic infrastructure of the Research Network.



Establishment of a particle therapy facility for cancer research

The single largest proposal submitted during the survey deals with the establishment of a centre for particle therapy with associated accelerator facility and patient facilities for cancer research, utilising the most up-to-date methods in cancer therapy employing high-energy particles (protons and light ions). A complete particle therapy facility, including the necessary diagnostics equipment (MR, CT, PET and x-ray), patient care, therapy planning, certification, buildings, etc. is estimated to cost somewhere in the order of DKK 1 billion. The facility would be used for cancer treatment, but also for research in health, natural and technical sciences. It is estimated that the particle therapy facility would be ready for use three years after the decision is made to establish it.

Investigations

In addition to the many specific proposals for new establishments, this survey has also shed light on areas requiring further investigation into needs with a view to recommending a national investment strategy. The areas in focus are registers and databases, the digitisation of cultural heritage and other collections of scientific material and the development of libraries as research infrastructures.

Participation in international research infrastructures

In addition to the need for funding for national research infrastructures, there also appears to be a need, beyond the DKK 300 million, for more funding to finance Danish participation in new international research infrastructures in areas where there are at present a number of major projects in the works. At the European level, there is currently a list of 23 infrastructure projects that could be realised within the next 10-20 years. During the survey, Danish researchers expressed an interest in participating in about half of these.



It is estimated that there is a need for the allocation of an amount increasing to DKK 100 million annually over the next 8-10 years for Danish membership in new international research infrastructures. It is crucial that the financing of Danish participation in international research infrastructures includes both membership fees and funding for derived research.

There is a need for continuity in the maintenance of Danish commitments to international research facilities, which typically entail agreements covering obligations spanning a timeframe of 20-30 years. The Council, therefore, recommends a clear institutional base of support in collaboration with relevant research institutions as well as regular assessment of the benefits to Danish research. It is often advantageous for Danish participation in international research infrastructures to be coordinated with other Nordic countries.

For some projects, the costs associated with possible Danish participation are still unknown. They depend on the type of membership, whether the membership is as part of a consortium, e.g. with the Nordic countries, whether there is a bilateral agreement at the institutional level or whether there is a government agreement. The following are three examples of international projects in which Danish researchers are very interested in participating.

European Research Observatory for the Humanities and Social Sciences (EROHS)

The objective of the EROHS project is to establish a European centre to map research trends and to develop and improve tools for research in the humanities and social sciences. Other tasks are the organisation of electronic libraries and research education programmes. The centre can, among other things, take the initiative to ensure the availability, digitisation, documentation, standardisation and development of research data as well as training in relation to this data within the social sciences and humanities.



European X-ray Free Electron Laser (XFEL)

XFEL was originally a German project located in Hamburg. In 2005, Denmark, along with 15 other countries, signed a Memorandum of Understanding (MoU) regarding the preliminary phase of the project. This was done upon the recommendation of the Danish Council for Strategic Research. An actual decision to implement the project will be made in the course of 2006-2007. The budget for the establishment costs for the period 2006-2012 is EUR 882 million. An annual Danish contribution would be somewhere in the order of DKK 10-20 million during the establishment phase and DKK 10-12 million during the operational phase, while further costs of DKK 5 million are anticipated for derived research. It is estimated that the greatest benefit from Danish involvement in XFEL would be achieved through membership from the outset, either at the national level or as part of a joint Nordic consortium. Denmark would be expected to contribute with know-how for the construction of the research equipment as well as with accelerator technology. Denmark will have to make a decision in 2006 as to whether to join XFEL.

European Spallation Source (ESS)

This proposal is a next-generation accelerator-based source capable of producing powerful neutrons of high quality. Sweden has offered to host it in Lund. A Danish share in the establishment of this project would be approximately DKK 150-200 million, spread over a seven-year establishment period. The annual operational costs would be DKK 15-30 million. It is important to consider whether the Danish environments in the field of neutron radiation should be stimulated and strengthened through the implementation of partnership agreements with other relevant research infrastructures in Europe as part of the groundwork for realising the ESS project, as the realisation of the project has a likely timeframe of 10 years or more.



The proposals presented above, along with the other proposals submitted using the requisite template, will all be under consideration. Should the assessment be positive, they will be included in the action plan for investment that makes up part of the Council's strategy proposal for research infrastructure.

4. Need for further investigation



During the survey, a number of interdisciplinary issues were identified which we recommend be investigated in more detail as soon as possible as part of the overall strategy:

- the ability of libraries to serve researchers
- the need for funding to cover the costs of digitising scientific material
- the need for coordination and financing of registers and databases

Research libraries

The development of the digital library entails new requirements and challenges for the research libraries' development of services and for the role they play in research dissemination. The libraries have to be able to handle and store large amounts of digital data as well as handle the rapid growth in the number of publications available digitally. In the responses submitted, many indicated a need to strengthen the library function, for instance through increased budgets for procurement and licenses, in order to ensure adequate access to new books and journals, access to electronic publications, etc. It is considered a substantial problem that licenses, copyright agreements and finances often limit access.

The research libraries finance and administer access to resources, but various commercial search engines compete with the libraries to offer users an interface with which to view these resources. A key issue with regard to the development of the libraries as infrastructures for researchers is to ensure that all researchers can gain access to published research findings. The Council therefore recommends that an investigation into the ability of libraries to serve researchers be initiated as soon as possible.

Digitisation of scientific material

The humanities research environments, in particular, have expressed a need for digitisation of data, but it is also crucial that collections in the natural sciences are digitised and, thus, made



available to Danish as well as international researchers. The Global Biodiversity Information Facility (GBIF), which is situated in Denmark, is an example of how digitisation can facilitate researchers to gain access to large volumes of data from a variety of collections all over the world. This is one means of responding to the opportunities and requirements of globalised research.

Digitising our cultural heritage is important for preservation and dissemination. The survey has revealed that in order for Denmark to attain the optimal benefit of the possibilities inherent in digitisation, careful planning and substantial investment are needed.

Consequently, the Council recommends that an investigation into the need for funding to cover expenses related to digitisation of scientific material be initiated quickly, in extension of the present process. In this connection, it is important to consider whether an overall digitisation programme is enough or whether it would make more sense to implement targeted, discipline-specific initiatives.

Registers and databases

Excellent registers and databases are a Danish position of strength, and this must be maintained. There is a clear need for the coordination of registers and databases in connection with research projects that have already been carried out, as well as for the securing of documentation and accessibility in connection with established and future registers and databases. The funding for the operation of ForskerServiceenheder (FSE – research service units) at Statistics Denmark and the Danish National Board of Health expires at the end of 2006. The Council recommends that an investigation into the need for the coordination and financing of registers and databases be initiated as soon as possible.

5 Strategy proposal for investment in national and international research infrastructures

The strategy for investment in and prioritisation of national and international research infrastructures comprises:

- **An action plan** for infrastructure investment over the next 10 years with adjustment in relation to the three specified investigations – which should be initiated immediately – and regular adjustment in relation to global developments.
- **A template** for proposals aimed at updating and for new national research infrastructures as well as for Danish participation in new international research infrastructures.

The Danish Council for Strategic Research proposes that the research council system be tasked with drawing up an action plan for investment in the best and most advanced research infrastructures, which are crucial to ensuring future research-related innovation.

The action plan should have a timeframe of 10 years with an increasing total investment of DKK 400-500 million annually, with short-term adjustments in relation to the findings of the three proposed investigations. The action plan should cover the necessary funding for: 1) upgrading existing research in infrastructures; 2) establishing new national research infrastructures and 3) Danish participation in new international research infrastructures.

The Council recommends that the assessment of the proposals for research infrastructures be conducted within the research council system through an open and transparent process and based on overall criteria for assessing: research quality and volume (number of researchers and needs); the uniqueness, strategic relevance and topicality of the proposal from a variety of angles (research, innovation, education); the desired effect of the proposal and effective utilisation of the total resources (value for money) and well-defined assessment procedures.

The Council recommends that the funding for research infrastructures be prioritised according to whether the investments can contribute to placing Denmark in a leading position internationally. They must match the objectives of focusing on



quality, strategic relevance and economies of scale, where the investments contribute to Danish research as a whole rather than spreading the funding. In this way, investment in research infrastructures can contribute to economic growth and scientific recognition as well as attracting leading international researchers.

Proposal template for updating and for new national research infrastructures or for Danish participation in new international research infrastructures

Updating and establishing new national research infrastructures and Danish participation in new international research infrastructures requires well-documented proposals from a large number of excellent Danish research environments that account for:

- Research and development to be conducted within the research infrastructure.
- Level, quality, topicality and relevance of the research within the planned research infrastructure.
- Opportunities for implementation of such research projects elsewhere in Denmark or abroad. Are there any planned partnerships with national or international research infrastructures in the field of research in question?
- Level of research and innovation in Denmark in the field in question compared to international conditions.
- Cost-benefits – What are the estimated costs of the research infrastructure (establishment and operation)? What is the estimated output of the research infrastructure stated in number of publications, PhDs, doctorates, graduates and technology transfer?
- Technical feasibility. Is it possible to establish the research infrastructure in question in Denmark? Are there any special building-related requirements, etc.?
- Plans regarding where in Denmark the research infrastructure should be located, including arguments for this location.
- Financing (research institutions, other national and/or international authorities, private sector).
- Conditions for access of external users.



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