ERA-Instruments
An ERA-Net initiative for promoting infrastructure funding in the life sciences

2007 - 2013 SEVENTH FRAMEWORK PROGRAMME

ERA-Instruments WP 1
Coordination and knowledge exchange

Task 1.3
Comparision of RI roadmaps

Deliverable 1.1
Comparision of RI roadmaps

Task leader
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1 Executive summary

In this report the national roadmaps on research infrastructure (RI) are analyzed for a selected number of countries, with particular focus on infrastructure for research in life sciences. Two lines are followed, namely 1) the analysis of the national situation and plans with respect to RI's and 2) the comparison of policies among countries, to find similarities and differences. The roadmaps were generated with different procedures and have different level of detail and purpose, and as a consequence also the analyses per country have different detail levels. Some countries do not have yet a roadmap, and in these cases we tried to retrieve information on RI policy from other documents, like for example the national R&D strategy, but we were not always successful.
In total, we could analyse 13 countries. Their RI policies for the life sciences show a number of similarities:

- a strong international orientation: participation to international facilities necessary, as RI's become more and more expensive, but it is also seen as fundamental to reach or keep high level in research; also, the developments in international policy on RI (especially ESFRI) are closely followed;
- the importance of life sciences research is widely recognized, and the RI's in this area of research constitute generally a significant portion of the total RI's included in the roadmaps; often they also receive a considerable portion of the available funding;
- the same fields of relevance in the LS research are identified: among others translational research, medical and natural collections, bioimaging, NMR and MS, genomics, animal models;
- the acknowledgment of the interdisciplinary character of LS research, as proved also by the importance assigned to synchrotron and neutron radiation facilities;
- the need to consider in the budget scheme the operation and maintenance costs of facilities, and to invest in training and acquisition of specialized personnel.

The analysis confirmed that many countries are following the trend set by the ESFRI Roadmap, and develop - or are developing - an own roadmap for research infrastructures. Clearly, countries are looking for a system to allocate the limited funds for research infrastructure in a coordinated way at the national level, at the same time taking into account the developments at the international level.

2 Introduction

It has become increasingly obvious that concepts and strategies for research infrastructure funding should be harmonised and coordinated within the EU. ESFRI has determined requirements for European RI funding and has presented a roadmap. Growing attention is paid to life sciences that rely on RIs of a less centralised, but more networked dimension. There is a clear need for action in the interdisciplinary area between physics, chemistry, biology and medical sciences as cutting edge instrumentation becomes increasingly expensive and, yet, indispensable for world-class research.

However, promotion of research policies, apart from the ESFRI projects, has been restricted so far to national efforts without managing these actions with a European view. Funding and research organisations can not afford to remain at the national stage with world-wide competition for the best scientists and the most promising projects. Frontier research is international since long and funding organisations have to follow scientists to the European level.

ERA-Instruments aims at initiating coordination and a sustainable network of 16 partners, including ministries, research councils, funding agencies and charities active in funding of life science RI. This European platform of relevant stake-holders, will set up comprehensive tools for adequate treatment of instrumentation related topics enabling conclusions for research policies on both a national and European level. The ERA-Net will focus on bio-analytical instrumentation (incl. post-genomic high-throughput techniques) such as NMR, mass spectrometry, microscopy, micro-array platforms etc. These midsize equipments have become a strategic essential strength for European countries. Promotion of RI funding in FP7 and support for new member states will also strengthen the position of European research.

3 About the deliverable and the work package/task

3.1 Objective

From the point of view of a European Research Area it is clearly desirable to compare national roadmaps with each other and with others such as the recently published ESFRI roadmap. Potential for cooperation as well as possible conflicts of interest should become visible. The result can also provide directions for organisations that are in the process of generating a national roadmap.

3.2 Approach

3.2.1 Detailed approach

The approach consisted of two parts, namely an analysis of the roadmaps per country and a comparison of the roadmaps among countries, to assess their similarities and differences.
In our analysis we tried to answer a set of questions, formulated in consultation with the Scientific Advisory Board.

For each country

- Definition of RI considered – what is actually considered under the definition of "research infrastructure"?
- Procedure adopted for roadmap – how was the roadmap generated, was that a top-down or a bottom-up process?
- Purpose of roadmap – what is the target group of the roadmap, and what does inclusion in the roadmap mean for a project?
- Life sciences vs. other research fields – that is, how much importance is given to the life sciences in the roadmap, in comparison with other research fields?
- Current and foreseen status of research in life sciences – what are the strengths and weaknesses, what are the expected developments?
- Gaps in RI and in RI funding – are there gaps in the funding of particular research areas of the life sciences, and are there plans for extra investments in those areas?
- National vs. international orientation – is the roadmap only about national infrastructures or also international ones? And how does the national RI policy relate to international developments, in particular ESFRI?
- Types of RI - Is the roadmap focussed more on new LS research infrastructure, or on the update of existing ones? And are these RI's single-sited or distributed?

Among countries

- Comparison of RI Roadmaps – in terms of RI considered, procedure and purpose
- Similarities and differences in the current and foreseen status of RI in life sciences and their consequences at European level – are the current situation and foreseen trends the same in all countries?
- Expected future developments and strengths in LS facilities at international level – what will be the international situation in the future?
- Expected future gaps and weaknesses – what kind of problems are expected?
- Current and foreseen options for cooperation and exchange of knowledge – can problems and challenges be better solved by means of international cooperation?

3.2.2 Information sources and countries considered

Countries

Naturally we started with the countries of ERA-net Partners, but we were actually also interested in Scandinavian countries, which are also active in the RI policy field. For the sake of comparison, we also planned to include in our analysis a number of non-European countries. We could analyze information from the following countries:

- Australia
- Denmark
- Estonia
- Finland

- France
- Greece
- Ireland
- Netherlands
- Norway
- Spain
- Sweden
- United States
- United Kingdom

Sources
Besides asking our ERA-Instrument partners for documentation, we also consulted WebPages and made direct enquiries to contact persons at the Ministries, Research Councils and Research Foundations.

Documents
In accordance with the task description, we focused on national roadmaps for research infrastructures. As not all countries have published such a roadmap, alternatively we looked for information on RI policy on other documents of national relevance, such as R&D strategies, recommendations of national committees, evaluations, internal papers on past experiences and future policies. In considering alternative documents we tried however to limit ourselves to those of relevance at national level and published within the last five or six years.

3.3 Results and conclusions

Annex 1 shows a map of the countries considered in our analysis. In green are the countries that have a national roadmap, and an analysis of it is given in this report. In yellow are the countries that are in the process of producing a roadmap. For Iceland and Estonia, publication of the roadmap is expected in the course of this year, in Italy the process of writing a roadmap has been halted until further notice due to the change of government in 2008. With regards to these three countries, we could retrieve information on RI only for Estonia. As for the countries represented in purple, we could not find any national document containing information on RI strategy; therefore they are not treated in this report.
In our comparison we considered all the single countries; one could however object that a comparison between USA and Australia, and Europe would be also interesting and even more appropriate in terms of scale. Europe, however, is still composed of independent countries each one with an own policy. Although there is an European roadmap, i.e. the ESFRI roadmap, this is not intended to substitute the national ones. ESFRI itself has not the purpose of dictating a unique European policy to which the national ones will be submitted; it is rather a coordinating effort, and a platform for discussion and exchange of knowledge among European countries. In this sense, the ESFRI roadmap is different from national roadmaps, thus also from the USA and Australian ones.

The analysis of the RI roadmap for each country is presented in Annex 2; in the following we present the results of the comparison among countries according to the points given in 3.2.1.

3.3.1 Comparison of RI Roadmaps

The comparison of Roadmaps of different countries leads to the following remarks:

Roadmaps refer in general to large-scale RI*;* how exactly these RI's are defined varies by country. In some cases a number of criteria is given, such as the minimum investment needed (United States) or a minimum procurement costs (Norway), number of employees and of external users (Denmark and Finland). Most countries, however, give only general definitions of RI's, or none at all. In all the roadmaps where a general definition of RI's is given, the common characteristics for RI's seem anyway to be the following:

- The costs of the considered RI's cannot be sustained by a single research institution nor even by the funding agency of the research sector it covers.
- The RI's are scientifically relevant – and therefore accessible - at both national and international level.

Roadmaps differ in terms of:

- Procedures: the procedure followed to generate the roadmap may vary for different countries.

Generally, the Ministry of Science and Education appoints - directly or through the Funding Agencies – a committee to supervise the generation of the roadmap. This can be a committee of prominent scientists (Denmark), of representatives of research councils (Sweden, United Kingdom, United States), or a mix of members of the academic community, policy makers and from the private sector (Finland). The committee engages in consultations with the research field and draws conclusions and recommendations on the RI strategy. The consultations can take place through panel discussions and workshops, but also through internet surveys. Also, the committee is always advised by panels of experts in the different research fields. In some cases a governmental department or organization take directly the initiative for the roadmap (Australia, Norway), but also in this case it is always advised by panels of experts.
In most cases – but not always, for example not in the case of Norway and Ireland – also a list of facilities of importance for the country is included in the roadmap. These may be selected, on the basis of a number of criteria (see next bullet) starting from a governmental ''long list'' (United Kingdom, Spain). Alternatively a call is issued for RI projects by the research community (Australia, Greece, Norway), and the selection is performed on the submissions.
Combinations of both procedures are also used – in the Netherlands case both submissions by the researchers and the list of the 35 projects from the ESFRI 2006 roadmap were considered for the Dutch roadmap.

- Criteria: When a selection of facilities is considered, different criteria may be used. Common criteria are of course the scientific relevance and the economic and social impact, however additional criteria such as for example knowledge transfer, training, embedding in the existing infrastructure might be considered. These criteria are not to be confused with the definitions of RI's mentioned above. These latter are usually more general and are intended as starting definition; the criteria are used for the selection of so-defined RI's to be included in the roadmap.

- Purpose/level of commitment: the roadmap is intended in some cases as advice on which facilities should be funded (Greece, Finland), in other cases as a list of facilities which are intended to be funded (United States, Australia), but also in the latter case the level of commitment can vary. Some roadmaps contain a disclaimer indicating that inclusion in the document does not imply any commitment for funding (France, United Kingdom).

- Level of detail: some roadmaps are very general (Denmark, Ireland), other present a detailed analysis of RI's for different research areas (United Kingdom, France); some prioritization of the RI's may also be given (United States, France, the Netherlands).

Roadmaps focus mostly on planning of future RI rather than on analysis of the current situation and gaps in RI and RI funding. Therefore, as can be concluded by reading Annex 2, these latter aspects could not always be highlighted in the analysis per country.

3.3.2 Similarities and differences in the current and foreseen status of RI in life sciences and their consequences at European level

The only differences among countries with respect to the situation of RI in the life sciences we could assess are the current availability of facilities, and the need for their upgrade. These depend on the particular situation of LS research in the country. For example, Estonia and Ireland denounce the lack of infrastructure as a consequence of a long-term lack of funding. They are both injecting considerable amount of funds in RI to compensate for this, but the feeling is that this impulse has to be continued in order to reach the level of the other European countries. For other countries, such as Norway and Australia, there is rather the need to identify the specific research areas where the challenges for the national research are, and to focus the investments in the related RI's.
There are on the contrary clear similarities in the views expressed in the roadmaps on the life sciences in general and on the facilities:

- Life sciences and LS-related research occupy a relevant position with respect to other research areas. This can be deduced in the different roadmaps from different data – for example from the subdivision of present funding, or foreseen need for funding per research field, or simply by looking at the number of projects listed in the roadmap for each area.
- The biomedical and life sciences research is getting more and more multi- and interdisciplinary. This is testified not only by the use for LS-applications of facilities like synchrotron, neutron and laser radiation sources, but also by the increasing importance of research at the edge between different disciplines, such as bio-imaging techniques and clinical and translational research.

- The international orientation is strong; the motivation is either to achieve or to maintain scientific excellence. All European countries acknowledge the importance of participating to international facilities, and to get maximum advantage from this participation many efforts are also directed towards a better coordination at national level, by creating for example a national node. Also, the high economic and social impact – besides the scientific advantage – of hosting an international facility is widely recognized. Facilities attract top-level scientists, but also high-tech industries and services, increasing the brain-gain. They provide also technological and industrial development in the area, and workplaces for the local population.
- Another strong motivation for international cooperation are the costs of facilities: life sciences research is developing rapidly, and requires instrumentation and facilities which are more and more sophisticated and require frequent updating. Therefore, it becomes difficult for a single country to sustain all the costs to construct and maintain such infrastructure.

3.3.3 Expected future developments and strengths in LS facilities at international level

Biomedical and Life sciences

The analysis of the roadmaps suggests that the biomedical and life sciences research activities will focus at international level on a number of topics, namely:

- clinical and translational research (in particular the connection between fundamental biomedical research and hospitals) – mentioned in the roadmap of 12 countries out of 13
- databases and collections (medical and tissues, natural sciences) – 10 countries
- imaging facilities – 9 countries
- animal models and facilities – 7 countries
- genomics – 7 countries
- NMR and MS facilities - 5 countries
- systems biology – 4 countries
- bio-security – 3 countries
- proteomics – 2 countries

Further, in general, the roadmaps indicate the need to coordinate activities and share information at international level – as a consequence, the trend is towards constituting international networks of databases. Also, many international facilities are being established (for example the ESFRI projects BBMRI, EATRIS, EUSYSBIO, ELIXIR, ECRIN, Infrafrontier, INSTRUCT). Common of these ESFRI facilities is their character of distributed infrastructure, mostly formed by connecting and upgrading existing national facilities in different countries.

Life sciences applications of material sciences facilities

Synchrotron and Neutron radiation sources and Lasers are usually classified as facilities for research on Material Sciences, however their use for life sciences applications has grown in importance in the last years. The importance of these infrastructures is testified by their prominent role in the ESFRI roadmap. Existing large international facilities (ESRF, ILL) are currently being upgraded, and new facilities are being built (XFEL, ESS). These facilities are by nature single-sited and very expensive, and therefore they are developed mostly as international projects, to be able to sustain all the costs. Nonetheless, a significant number of countries has also own national facilities – for example the United Kingdom, Norway, France and Spain.

3.3.4 Expected future gaps and weaknesses

Two main issues are generally identified with respect to research infrastructures:

1. The need to take running and maintenance and update costs, and not only construction costs, into account. The equipment becomes more and more sophisticated and needs specialized personnel to be handled; moreover, in order to keep the pace in the rapidly evolving LS research field, it has to be upgraded often. As a consequence, the operational costs are considerable and must be taken into account in the funding scheme of a facility.
2. The need for specialized personnel to keep facilities running: finding and keeping the high qualified personnel needed for RI is becoming increasingly difficult, and in order to solve this problem it is necessary to invest significantly in training and career possibilities.

3.3.5 Current and foreseen options for cooperation and exchange of knowledge

As already discussed in 3.3.2, the international cooperation is seen as essential to reach and/or keep a competitive level in research. Although the roadmaps do not explore concrete options for

cooperation and exchange of knowledge, they all clearly indicate that international research infrastructures are considered as an important vehicle for this purpose. In fact, they attract the most talented researchers from abroad and they encourage international cooperation. For the same reasons, hosting a facility is of course even more desirable, as this translates in brain-gain for the hosting country (that may be the reason also why even national facilities are often open to foreigner researchers on the basis of scientific merit).
Moreover, RI's usually attract other R&D activities, in particular in the high-level industry, favoring its cooperation with the scientific community and giving an impulse to the local and national economy. For these reasons there is a big drive from all countries to host an international RI or – for distributed facilities – to host a node of an international RI, usually by connecting to the international network the own national facility for a particular research area. This latter can be interpreted as a decentralization of infrastructure in Europe, and it is certainly taking place in the case of the life sciences and biomedical infrastructure which, as already pointed out, has mostly a distributed character. Costs issues, and also the need to create focus and mass, lead to coordinated efforts to optimize the distribution of equipment in Europe, creating a decentralized system of infrastructure.

3.4 Issues encountered

During our work we encountered the following issues:

- Quality and quantity of information

Some countries do not have roadmaps for RI's, and alternative documents (i.e. general RD&I strategies) often do not address directly infrastructure. As a results, the level of detail of our analysis resulted to be different for different countries.

- Sources of information

Besides asking the ERA-partners for documentation, we also searched for information on the WebPages of ministries and research councils. Information found on the Internet, however, needs to be carefully checked to assess whether it is the most updated information, and whether it is complete or some other relevant document is necessary. For this purpose, we contacted persons at the ministries and research councils in many countries, but we did not always receive (satisfactory) answers.

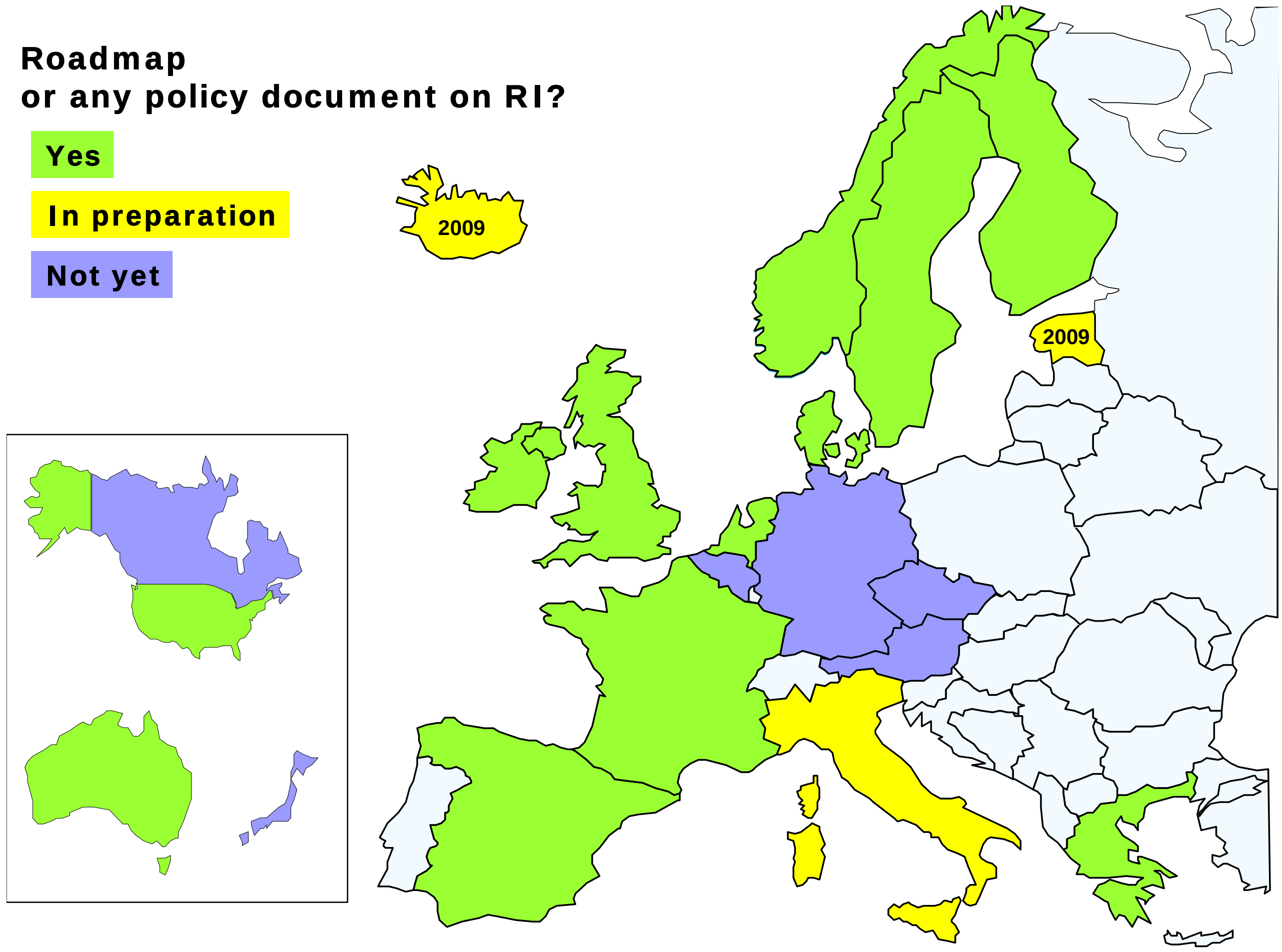
- Keeping our information up-to-date

Other countries are now producing or updating their policy, so we have to track the developments and update (or partially re-write!) our analysis as new policies are published. This was the case, for example, for the 2008 update of the Australian roadmap, which was published after our analysis of the 2006 Roadmap was completed. The same happened for the roadmap of the Research Councils UK, of which a new version was published in July 2008. And finally, the Finnish map was published in February 2009, and had to be included when the analysis was already in the final stages.

ANNEX 1

Countries considered

for the Roadmap Analysis


Roadmap
or any policy document on RI?
Yes
In preparation
Not yet
2009
2009

ANNEX 2

Analysis of National

Research Infrastructure Roadmaps

Australia

An AUD 542 million fund for research infrastructure was allocated in 2004 for a period of seven years to the National Collaborative Research Infrastructure Strategy Program(NCRIS).

Key principles of the NCRIS programme are:

- investment in RI should aim at maximizing the contributions of the R&D system to economic development, national security, social well-being and environmental sustainability
- RI resources should be focused in areas where Australia is or has potential to be international leader
- Development of RI on a collaborative, national, non-exclusive basis (i.e. not institutional level or small collaborative scale)
- As few as possible access barriers, access based on merits
- The whole-of-life costs of major RI should be taken into account, with funding available for operational costs when appropriate;
- To enable the fuller participation of Australian researchers in the international research system.

In 2006, NCRIS published a Strategic Roadmap [1], based on the NCRIS principles listed above and with the purpose to indicate the priority areas for the next 10 years.
The roadmap focuses on the large research infrastructure, characterised by a national and mostly also international dimension. Smaller research infrastructures, from institution to project level, are covered by other funding than those of NCRIS.

Building up on this roadmap, an updated version, the Strategic Roadmap for Australian Research Infrastructure [2] has been published in 2008.

The roadmap process
The 2006 roadmap was the result of extensive consultations with the research community and other stakeholders. The 2008 version can be considered as an update of the 2006 roadmap, to evaluate the implementation so far of the RI strategy presented and to identify critical elements. The review was carried out by releasing, for consultation, first a discussion paper and subsequently a draft of the roadmap. The NCRIS Committee was in charge of the review, assisted by Expert Working Groups for the different research areas.

1. Life sciences vs. other research fields

The 2006 Roadmap identified 16 investments areas, called capabilities. Capabilities in – or related to - the field of life sciences were:

- Evolving bio-molecular platforms and informatics
- Integrated biological systems
- Characterisation
- Fabrication
- Biotechnology products
- Translating health discovery to clinical application
- Population health and clinical data linkage

Twelve out of the 16 identified capabilities received funding from NCRIS; the distribution of investments is shown in Figure 1.
Considering as life sciences the capabilities:

- Evolving bio-molecular platforms and informatics
- Integrated biological systems
- Biotechnology products
- Networked bio-security framework
- Population health research network

The total amount of funding to these capabilities is about AUD 210 Million; note that in this sum we have not included the funding to the LS-related part of the capabilities Characterization and Fabrication.

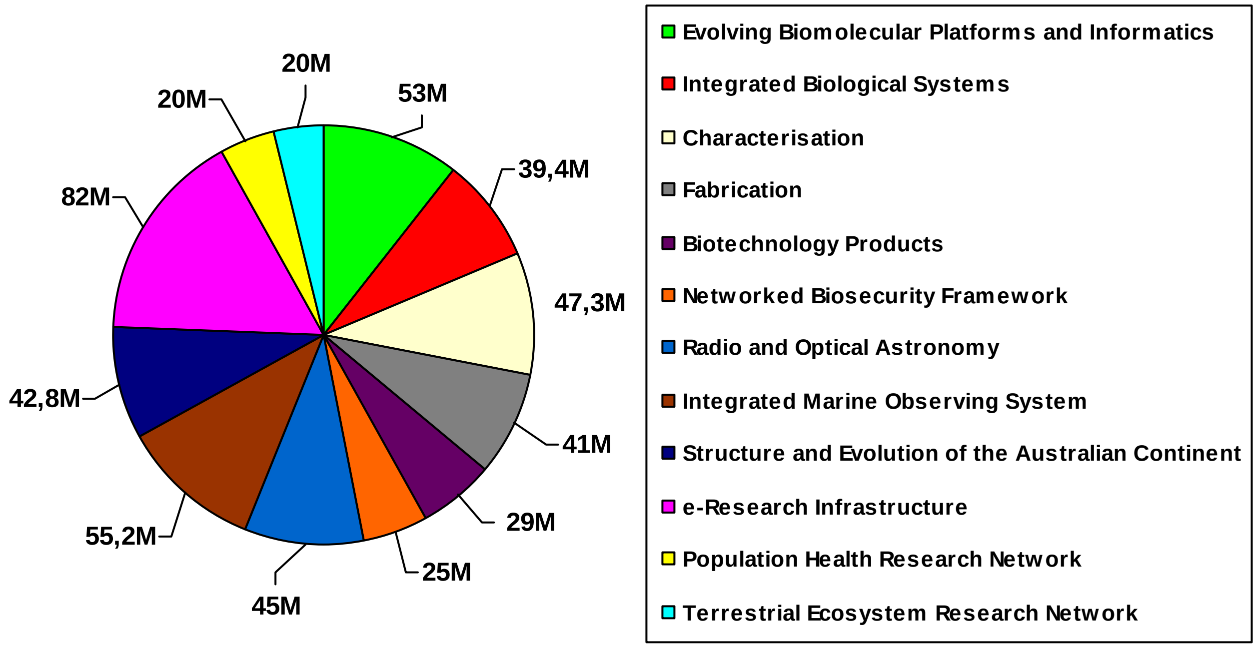


Figure 1 – NCRIS allocated funding (in AUD) for the capabilities identified in the 2006 Roadmap.

2. Current and foreseen status of RI in life sciences

In the updated version of the roadmap the capabilities of the 2006 version are still confirmed as priorities for funding, however they have been re-shuffled and grouped in six "capability areas", to evidence the linkage between complementary areas and to have a better view of the needs for infrastructure.

The Roadmap identifies 6 "Capability areas":
1. eResearch Infrastructure
2. Environmentally Sustainable Australia
3. Humanities, Arts and Social Sciences
4. Biological Discovery and Health
5. Frontier Science and Technology
6. Safeguarding Australia

The roadmap does not present a list of facilities like other countries do, but rather indicate the needs for infrastructure for each research field within the capability areas.
Life sciences can of course be identified for its major part in the capability area "Biological Discovery and Health", but it plays a role also in three other areas. The four capabilities areas are listed here with, for each capability, a list of the LS-related specific infrastructure needs:

Environmentally Sustainable Australia
- Need for further development of predictive modelling capabilities and data presentation and visualization techniques
- Further development of Atlas of Living Australia
- Development of environmental genomics facilities for collection and analysis of biodiversity data.
- Linkage with genomics platform under the Integrated Biological Discovery capability (capability area Biological Discovery and Health)
- Further development and service provision of advanced plant phenotyping techniques through the NCRIS-funded Australian Plant Phenomics Facility (APPF)

- Access to molecular biology technologies and tools for marine observation, also under the Integrated Biological Discovery capability

Biological Discovery and Health

- <u>Integrated biological discovery</u>
    - o Need for further strengthening van Bioplatforms Australia (BPA) and Australian Phenomics Network (APN)
    - o Investment in rapid high throughput DNA sequencing and protein/antibody arrays;
    - o Implementation and extension of bioinformatics at national level;
    - o Use of siRNA and small molecule libraries to probe cellular responses and build up a systems biology model of different cell types; these models can then be used to make predictions as to which proteins are involved in different disease states;
    - o Need for improved NMR and MS facilities;
    - o Access to biobanks and large scale sequence data

- <u>Translating Health Discovery into Clinical Application</u>
  Despite its inclusion in the 2006 roadmap, this capability has not received funding. There seems actually to be not so much need for facilities, but rather need to invest in network infrastructure to make the existing ones more accessible.
  Particular needs for RI are:
    - o An integrated network of preclinical testing facilities including ADME, animal disease models, biomarkers, and toxicity testing. There is in particular a need for expertise and infrastructure in toxicology.
    - o Multimodal imaging technologies for the monitoring of metabolism under various experimental conditions, potentially through an expanded Large Animal Research and Imaging Facility;
    - o Support for clinical trials networks, in terms of staff, statistics services, tissue banks and support information systems;
    - o Continuation of existing NCRIS-funded infrastructure for large scale mammalian and non-mammalian cell based manufacture of recombinant proteins as potential therapeutics

  Further, the establishment of the following RI's is advised:
    - o A national small molecule repository and a national screening network to identify small molecule drug candidates
    - o National large animal preclinical and testing facility
    - o Increased capacity in high quality animal pathology and phenotyping
    - o Infrastructure for research on the medical application of nanoscale products from biological and chemical research

- <u>Population and biological Health Data Network</u>
  Currently, the Population Health Research Network (PHRN) is being established, funded by NCRIS, to connect health data sets and biological sample banks at national level. Further infrastructure needed:
    - o Database related ICT infrastructure;
    - o Infrastructure for the continuous maintenance of cohort and clinical studies of national relevance;
    - o A coordinated network of physical facilities for secure storage, retrieval, management and use of biological samples;

Frontier Science and Technology

- <u>High-level Microscopy and Microanalysis</u>: need for increased capacity and support for existing techniques, as well as new microscopy and optical spectroscopy techniques
- <u>Neutron scattering:</u> enhancement of OPAL technical capabilities (additional beamlines and techniques)
- <u>X-Ray Techniques</u>: additional beamlines for Australian Synchrotron, keep options for access to synchrotron overseas
- <u>Imaging:</u> more capacity and support for existing techniques; MRI techniques; inclusion of NMR Spectroscopy
- <u>Nano-material fabrication</u>: further investment needed in the bio- and chemo-manipulation of nanostructures.

Safeguarding Australia

- Need for an integrated approach to biosecurity research at national level.

3. Gaps in RI and in RI funding

Gaps in Research Infrastructure are not directly addressed in the roadmap, however the feeling – for the life sciences – is that a better linkage is needed between capabilities whose research areas are overlapping. In this sense, the reshuffling and grouping of capabilities is also intended to favour cooperation, to optimize the usage of infrastructures and therefore the return of investments.

The Australian funding system classifies research infrastructures in terms of the amount of funding they require and of their impact on the national research agenda. These categories of infrastructures are then coupled to different funding schemes:

- Investments in RI's at the research institution level are streamlined through the Research Infrastructure Block Grants (RIBG)
- RI's that are too expensive at the level of a single institution, but can be implemented in a collaboration of institutions are referred to programs such as the Linkage Infrastructure and Equipment Fund (LIEF) of the Australian Research Council (ARC), or the Enabling and Equipments Grant of the National Health and Medical Research Council (NHMRC).
- Larger RI, with a national, strategic or landmark character, ask for ad-hoc funding

The roadmap focuses on this latter category, and in particular on RI's with national or systemic/strategic character.

As for gaps in funding, it is worth mentioning that not all the capabilities presented in the 2006 roadmap have received funding. The capability "Translating health discovery into clinical application" was set – with other three capabilities – to be reviewed for possible investments in a successive round planned from 2007 [3].

4. National vs. international orientation

As stated in the 2008 roadmap, top-level facilities can give a further impulse to Australian research at international level, but they are also intended to attract researchers from overseas. At the same time, the Australian participation to international facilities has also an high priority, and indeed Australia participates in several international project. As an example, Australia is currently negotiating with EMBL to host EMBL-laboratories.

5. Types of RI

Different types of RI are not addressed directly in the roadmap, as there is no list of specific facilities to be financed.
For life sciences there seems to be the need to update the existing facilities, as well as to integrate them with new RI's. As for the kind of infrastructure, there are single-sited as well as distributed facilities, with a slightly higher number of the latter in the life sciences.

References

[1] National Collaborative Research Infrastructure Strategy (NCRIS), *Strategic Roadmap,* February 2006.

[2] National Collaborative Research Infrastructure Strategy (NCRIS), *Strategic Roadmap for Australian research Infrastructure,* September 2008.

[3] National Collaborative Research Infrastructure Strategy (NCRIS) – *Investment Framework, April 2006*

Denmark

The main document about Danish policy on research infrastructure is “Future research infrastructures-needs survey and strategy proposal” [1]. It is the report of a survey performed in 2005 by the Danish Council for Strategic Research upon request from the Danish Ministry of Science, Technology and Innovation. Besides an analysis of the existing infrastructure at national and international level and of the need for updates, the Council was also asked to propose a strategy for the access to new national and international facilities.

The roadmap process
The Danish Council for Strategic Research appointed a taskforce to conduct the survey, which involved consultations with public research institutions, scientific research councils, technological institutes and large companies, and also the research community. The survey took place through a website specifically set up for this purpose, and the preliminary results were discussed at a conference in Copenhagen in May 2005.
In order to be included in the survey, existing infrastructures had to be of a larger scale than feasible for a single institution. They had to have procurement costs totalling at least DKK 5 million in the areas of natural science and technical research and of agricultural research, and of at least DKK 15 million in health science research. There were also additional requirements, regarding for example the number of external users, and of employees needed for the running of the facility.

1. Life sciences vs. other research fields

The purpose of the roadmap is a general discussion on Danish national and international policy, therefore there is no division in scientific areas, only general advices with a very small number of examples (some of which are life sciences-related).

2. Current and foreseen status of RI in life sciences

With respect to the national situation, the recommendations of the Council taskforce are the following:

1. Overall need for upgrading of existing RI: short term investment needed of DKK 300 million.

2. There is an overall interest for investment in new RI for a total of DKK2 billion.
   Expressions of interest are at different level and with different budgets.
   Among all the proposals, the committee mentioned the following facilities as particularly relevant on the short term:
   - ASTRID 2000: replacement of the existing synchrotron facility ASTRID with a new one.
   - Increased investment in supercomputing facilities for all research fields, for a.o. biotechnology. Particular emphasis is given to the necessity for long-term funding of the Danish Centre for Grid Computing
   - Establishment of a particle therapy facility for cancer research
   - Further investigation of the needs for a national strategy for databases and registers, and collection of scientific materials

3. To provide the funding necessary for digitalisation of scientific material (the Global Biodiversity Information Facility in Denmark is cited as an example)

4. To further investigate the needs for coordination and financing of databases and registers

3. Gaps in RI and in RI funding

See previous section.
The Committee proposes also a strategy for investments in the infrastructure on both national and international level. The strategy should consist of a 10-years action plan with an increasing total investment of DKK 400-500 million annually to invest in upgrading of existing RIs, establishing of new national RIs, and participation to international facilities.

The funding should be assigned by means of an open and transparent assessment procedure, based on a number of criteria related to the scientific and strategic impact of the candidate facility for the Danish international position and to the “value for money” of the facility.

4. National vs. international orientation

With respect to the international research infrastructures, the following recommendations are given:

- To finance Danish participation in new major international research infrastructures in the form of membership fees as well as funding of derived research
- To guarantee continuity in the already existing participation agreements to international research infrastructures
- Participation at the international level can be advantageous within the Nordic cooperation.

International facilities mentioned in the roadmap which are life sciences-related are X-FEL and the European Spallation Source.

5. Types of RI

Types of RI are not specified, as the report has a general character. The examples cited are of all types.

Recent developments

The National Programme for Research Infrastructure 2007-2009 [1,2] is a DKK 600 million (ca. 80 million euros) fund for investments in research infrastructure at national and international levels.
The funding is equally spread over the three years (DKK 200 million per yearly call).

The funding is available for the following purposes:

- Establishment of major research infrastructures
- Danish membership or participation in major international research infrastructure
- Preliminary projects/project maturation (this latter only in 2007 call)

The programme supports projects that extend beyond what research institutions can be expected to finance on their own. Consequently applications must be for funding above DKK 20 million for the establishment or upgrading of infrastructure.

XFEL
Denmark has signed the Memorandum of Understanding (MoU) for this facility, and is contributing with DKK 26 million[3]. This in the framework of the National Programme for Research Infrastructure mentioned above.

European Spallation Source
Denmark is supporting Sweden as hosting country for this facility [4].

References

[1] Danish Council for Strategic Research, *Future Research Infrastructures – Needs Survey and Strategy Proposal* , Danish Research Agency, December 2005.

[2] Danish Agency for Science Technology and Innovation, *Calls for application of the National Programme for Research Infrastructure 2007 and 2008*, http://en.fi.dk/

[3] Danish Ministry of Science Technology and Innovation, *DKK 200 million Ensuring New Scope for Danish Research*, press release, 14 December 2007.

[4] Danish Ministry of Science Technology and Innovation, *Opening for Denmark: Co-hosting European Research Facility*, Press release, 7 April 2008.

Estonia

A white paper on the Estonian policy for Research Infrastructures is being prepared and will be published in the course of 2009. At this moment, the only document available is the national R&D strategy for the period 2007-2013 [1].
The document does contain general information about the research infrastructure policy, which is summarized here.

The organisation of RD&I in Estonia has undergone a major development since 1990, essentially steering towards a quality driven scheme for the funding of research and research infrastructure. This allows Estonia to reach an internationally competitive level in RD&I, however the status of the research infrastructure in Estonia is mentioned as a major problem.
The lack of investment for upgrading research facilities and for building new ones in the last 15 years has resulted in largely outdated infrastructure. Pilot infrastructure development programmes are mentioned for the period 2006-2008 (the document is published at the beginning of 2007), but more, long-term investments are needed.
The outdated infrastructure is also considered as one of the major causes for the lack of researchers and top-level specialists, as it makes pursuing a research career in Estonia less appealing for young people.

Major public investments are needed for construction and upgrade of research infrastructure, and these infrastructures should be used to encourage the cooperation between public research institutions and private enterprises, in order to stimulate also private sector investments in RD&I.
The target is to have a proportion of 80% of upgraded or new RI's by 2013, against a percentage of 20% in 2004.
Among the RI-related action items in the strategy:

- joint use of large scale infrastructure will be encouraged to favour the cooperation between universities and other research institutions;
- a network of Estonian core laboratories will be created, focused on the needs of the Baltic Sea region and capable to provide services also to industries;
- development of science and technology parks in cooperation with the public and private sectors, the latter including international companies
- possibility for Estonian researchers to participate in international research facilities – Estonia is member of EMBC, CERN and ESA, and intends to increase the participation in international research organizations and facilities. Also, the development of distributed RI, such as data collection networks, computational resources, etc. will be encouraged.

Also, national R&D programmes will be launched for the development of what are considered as key technologies, that is: information and communication technologies, biotechnologies, material technologies; and for a number of socio-economic issues, among which health care.

The strategy sets as target an increase of the public expenditure in RD&U to 1,05% of the GDP by 2010, and to reach the Lisbon Strategy target of 3% of GDP by 2014.

References

[1] Estonian Ministry of Research and Education, *KNOWLEDGE-BASED ESTONIA - Estonian Research and Development and Innovation Strategy 2007-2013*, 2007.

Finland

The Finnish roadmap [1] has just been published at the time this report is being completed.
Besides a list of the national and international RI to be financed in the near future, the roadmap gives also recommendations for the development of a national body dedicated to research infrastructure policy.

The roadmap process

The Finnish roadmap was prepared by the Federation of Finnish Learned Societies based on a request from the Finnish Ministry of Education. The Ministry appointed a Steering Group composed of members of the academic community, administration, funding parties and the private sector, with the task of supervising the process, from the definition of the criteria for the selection of infrastructures, to the formulation of conclusions and recommendations.

The roadmap process was started at the beginning of 2008 with a seminar on the Finnish involvement in ESFRI and with a internet survey, in which public and private research institutions were asked a.o. to submit proposals for the national roadmap.
The national infrastructures selected for the roadmap had to fulfil the majority of a number of criteria, among which the scientific, economic and social relevance, the high investment costs, the added value for training of researchers and the presence of enough critical mass of users. For international RI's the Steering Group considered the scientific relevance, utilization and costs for the Finnish parties and also the utilization of infrastructure in Finland.
The selection of the large number of submitted proposals was carried out, also by means of hearings and a information and feedback seminar, by three international expert panels for the research areas:

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

1. Life sciences vs. other research fields

Figure 1 shows the total operating costs per year (in 2007) for the existing Finnish RI's, divided by research area. With about 21 M€/yr, the Biomedical and life sciences RI are second in investments only to the Social Sciences and Humanities sector.

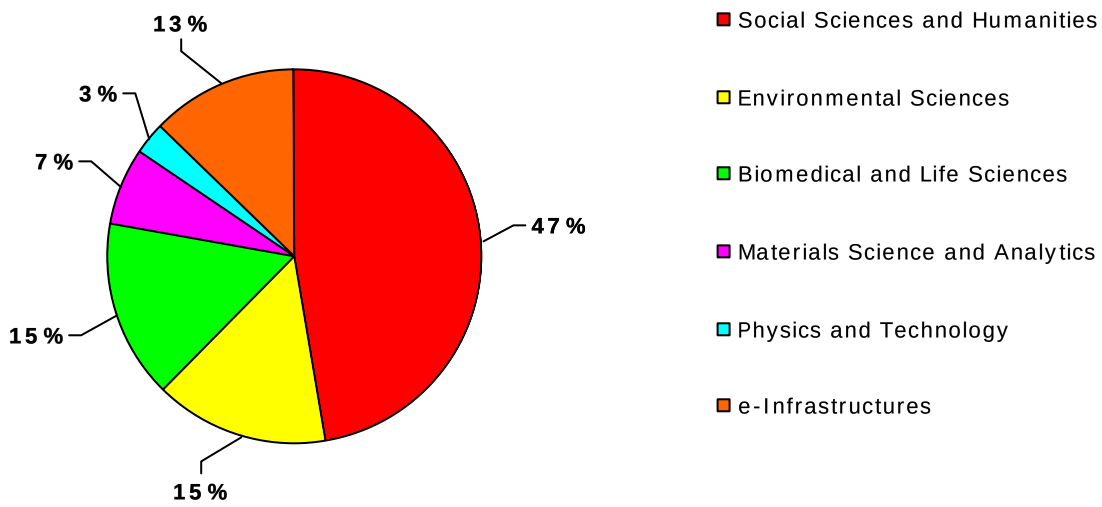


Figure 1 –Estimated operating costs (in M€/yr) in 2007 for existing national research infrastructures

As for the RI included in the roadmap, an overview of the LS and LS-related projects is shown in Table 1, where also the estimated construction costs and operational costs for Finland are given.

		Construction costs (M€)	Operational costs (M€/yr)	National / ESFRI
Biomedical and Life Sciences	**Infrafrontier**	5.1	0.4	ESFRI
	EATRIS	10.0	n.a.	ESFRI
	ELIXIR	16.5	1.0	ESFRI
	BBMRI	17.0	1.0	ESFRI
	National Virus Vector Laboratory (AIVVectorCore)	Not existent	0.5	National
Materials Science and Analytics	**ESRF**	0.6	0.06	ESFRI

Table 1 – Research infrastructures for life sciences included in the Finnish roadmap.

2. Current and foreseen status of RI in life sciences

With respect to biomedical and life sciences, according to the LME international expert panel Finland is strong in several research areas. However, the panel recommends increasing the efforts for the commercialization of the results. Another recommendation of the panel regards the Biocenter Finland, a cooperation between the biocentres of six Finnish universities: in the panel's opinion, its coordination activities could be improved. Also, a general remark that regards the biomedical and life sciences research area is the importance of collections and national registers. It is recommended to invest more in their digitization and standardization, and in making them available internationally.
As for the Materials Sciences, the importance of synchrotron radiation for biosciences is explicitly mentioned. Finland participates with the Nordic Cooperation to ESRF, and has also access to the Swedish Max Laboratory: also in this field, the recommendation is to increase the national coordination towards extensive multi- and cross-disciplinary research.
Finally, more general recommendations of the experts' panels are a.o.:
- To realize a more efficient utilization of national RI's by means of a better coordination within the scientific community
- To improve coordination efforts within each research field, but also in multidisciplinary research.

3. Gaps in RI and in RI funding

The expenditure for national RI's is estimated at about 130 M€/yr, to which about 30 M€/yr for participation in international RI projects have to be added (only membership costs related investments are not included in the estimate).
The implementation of the roadmap projects will require even higher yearly investments: it is expected that over 200 M€ will be needed between 2010 and 2016 for carrying out the most urgent projects. Moreover, the different scheduling of the projects will require a coordinated allocation of funds in time. Therefore, it is recommended to have a centralized funding system to coordinate this; in addition, this system should also take care of the participation fees to international facilities and of the coordination of the national related activities.

4. National vs. international orientation

The importance of the Finnish participation in international RI projects is one of the main remarks of the roadmap. Finland already participates in a number of international projects, under which, for the LS-related research, EMBL, MAX-lab, en ESRF. The feeling is however that the opportunities offered by such participation should be better used by the researchers.
A greater involvement of Finland in ESFRI projects is recommended, and Finland should seek more positions of responsibility in international RI's. Also the importance of the cooperation with the other Nordic countries is stressed.

The involvement of Finland in large international facilities currently results in a commitment of about 30 M€/yr only in membership contributions. The advice is to increase the involvement in terms of in-kind contributions, to give an impulse to the national research and cooperation with the corporate sector.

5. Types of RI

The life sciences facilities listed in the roadmap are, with the exception of ESRF (update) all new facilities. With the exception of ESRF and the National Virus Vector Laboratory, the facilities are distributed ones.

References

[1] Ministry of Education of Finland, *National-level research infrastructures: present state and roadmap – Summary and recommendations*, Helsinki 2009.

[2] The Finnish Research Infrastructure Survey and Roadmap project pages, http://www.tsv.fi/tik/english.html

France

The recently published French roadmap for research infrastructure [1] defines as "large scale infrastructure" a facility established in order to conduct relevant research and that can provide service for one or more large scientific communities. The costs of construction and operations are such that they justify decision-making and funding at national level, or even at international level, and multiannual programming. The governance is centralized and the guidance and assessment are carried out by committees of top scientists. Access is open to all on the basis of scientific excellence.

The roadmap process

The compilation of the roadmap followed a "bottom-up" approach, focusing on the views of the scientific community on both existing and future research infrastructures, at national level but also in terms of participation to international projects.
From the resulting list of facilities a number of experts' working groups selected those to be included in the roadmap, on the basis of a number of criteria:

1 Scientific criteria
- Response to the needs of the scientific community
- Quality of the scientific output expected

2 Teaching criteria
- Accessibility to PhD students and postdocs
- Accessibility to higher education

3 Criteria on knowledge transfer
- Importance of the expected industrial partnerships
- Importance of the expected patents

4 Economic criteria
- Relevance of the resulting jobs and businesses
- Impact on local businesses.

1. Life sciences vs. other research fields

The French roadmap lists about 90 research facilities, classified as follows:
- **Existing facilities**, operational at the publication date of the roadmap;
- **Decided facilities**, which are not yet operational, but there has been already a decision to provide funding. They can also be distributed facilities, for which the nodes already exists and only the coordination structure has to be developed;
- **Planned facilities**, that is facilities for which the design is well advanced but the funding has not yet been assured and long-term projects that depend on the raising of technological barriers or whose design is still being developed. As is the case with many of the roadmaps analyzed, here also it is stressed that – for the planned facilities - inclusion in the roadmap does not imply a commitment for funding. Indeed the available budget will probably be insufficient to finance all the projects.

The facilities are further divided in 6 research areas:
- The Planet
- The Universe seen from the Earth
- Particles and Nuclei
- Matter
- Information, communication and computing services
- Social Sciences and Humanities
- Life Sciences and Health

The roadmap facilities related to life sciences are listed in table 1.

			National / international	Existing / decided / planned	Single-sited / distributed		Budget (French contribution for international projects)
Biology and Health Sciences	**INSTRUCT**	Instruct nodes for structural biology at Grenoble and Strasbourg	international	existing	distributed	A third node is being formed at Ile-de-France	4-5 M€/yr
	IEHS – P4	Biological safety level 4 Laboratory of Lyon	national	existing	single-sited		2 M€/yr
	CRB	Centre for biological resources - Biobanks	national /international	existing	distributed	Participates to BBMRI and EMBRC	7 M€/yr
	Neurospin	Preclinical to clinical brain research with high field MRI	national/international	existing	single-sited	Participates to EATRIS	14,5 M€/yr
	EMBL		international	existing	distributed		13 M€/yr
	IdG (CNS-CNG)	Genomics Institute	national	existing	single-sited		33 M€/yr (estimate for 2008)
	CELPHEDIA	Modeling of vertebrates	national/international	decided	distributed	Participates to Infrafrontier	30 M€/yr
	RIEHS – A3	Network of high security laboratories	national	decided	distributed		Constr + equipment 100 M€ Operations 16M€
	PREDECOB	Biomedical cohorts programme	national	decided	distributed		2M€/yr
	CIC	Clinical investigation centres	national/international	decided	distributed	Represents the French participation in ECRIN	50M€/yr for existing CIC's
	LIFEWATCH	Collections of taxonomic data	international	planned, high priority	distributed		
	Translational research	Creation of a translational research centre	national/ international	planned, high priority	distributed	Participates to Neurospin and EATRIS	20M€/yr
Materials	**ESRF**		international	existing	single-sited		20M€/yr
	SOLEIL Synchrotron		national	existing	single-sited		Construction 350M€ annual budget 54
	LLB	Neutron source	national	existing	single-sited		Constr: 400M€; Budget 12 M€/yr
	ILL	Neutron source	international	existing	single-sited		26M€/yr
	High field NMR	High field NMR centres	national	existing	distributed		5M€/yr
	XFEL		international	decided	single-sited		
	ILE	Precursor of ELI	national	decided	single-sited		Constr.: 27,1M€ Oper. 4,3 M€/yr
	ILL upgrade phase 1		international	decided	single-sited	Phase 1 approved	Phase 1: 25M€
	ESRF upgr. phase 1		international	decided	single-sited		
	ESRF upgr. phase 2		international	planned, high priority	single-sited		
	ILL upgr. phase 2		international	planned, high priority	single-sited	Not yet approved	
	ELI		international	planned	single-sited		
	ESS		international	planned	single-sited		

Table 1 – List of life sciences and LS-related facilities included in the French Roadmap

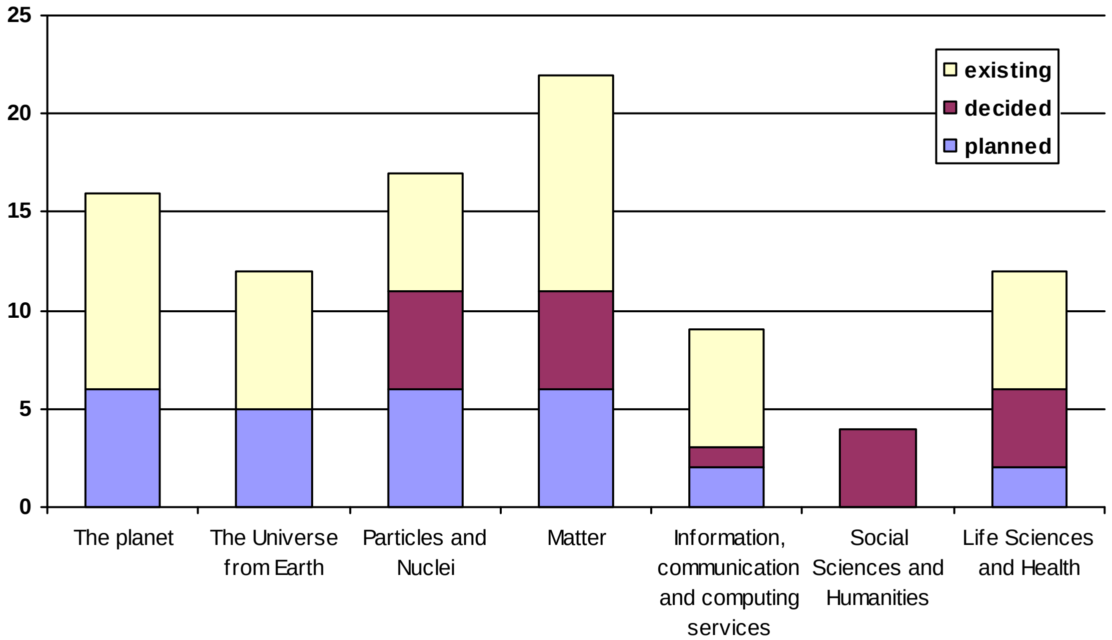


Figure 1– Number of facilities listed in the French roadmap 2008 for each of the considered research areas and for each category (existing, decided, and planned)

Figure 1 reports the number of facilities for each research area and for the different stadia of implementation. Besides 12 life sciences facilities, there are also 13 projects with application in life sciences, for a total of 25 LS-related projects. It has to be noted that the ESRF and ILL upgrades are considered in the roadmap separately from the ESRF and ILL facilities and that the phase 1 and 2 of the upgrades are also considered separately: we kept the distinction also in our analysis.

2. Current and foreseen status of RI in life sciences

The rapid progress in the research and technology related to life sciences and health has led to the need for larger and more complex facilities in this field. Research infrastructure is growing not only at European level, but also at national level within France. In order to streamline the increased flow of funding for this research areas, the "**Biology, Health and Agronomy Infrastructure" (IBISA)** was created [2]. IBISA is a consortium of the French national research agencies (INSERM, CNRS, INRA, CEA, INRIA, INCa - National Cancer Institute), Universities and the Ministry of Higher Education and Research, with the following tasks[2, 3]:

- It manages access to common service activities of the former Centers: CNS (National Sequencing Center) and CNG (National Genotyping Center), now combined to set up the Genomics Institute under the responsibility of CEA, the agency presently in charge of it.
- It coordinates the national labelling and support policy for the Platforms and Infrastructure in life sciences.
- It promotes the setting up of dialogue and steering structures of the Platforms at regional level which are expected to become privileged stakeholders of IBISA .
- It promotes the activities of animation (schools, workshops, etc…) around the Platforms.

For each of these missions IBISA launches calls of proposals.

3. Gaps in RI and in RI funding

Not addressed in the roadmap.

4. National vs. international orientation

The French scientific community is strongly oriented towards cooperation at the international level, and the French research policy is also in tune with the European developments, such as ESFRI. Indeed, about one third of the facilities included in the French roadmap are international facilities from the ESFRI roadmap, and for the LS-related projects the percentage is actually higher, as 16 out of the 25 projects are international projects.

5. Types of RI

Half (46) of the 90 facilities listed in the roadmap are existing ones, the remaining are in construction or planned; for the LS-related projects the ratio is slightly higher with more new facilities.
As for the kind of facilities, in the life sciences and Health almost all facilities are distributed, and also among the single-sited there are national centres that participate as node in international distributed facilities. The LS-related facilities in the field of Matter are on the contrary almost exclusively single-sited, but this is to be expected as they are mostly radiation source facilities.

Additional strategy documents at national level

Centre National de la Recherche Scientifique – CNRS
Currently CNRS participates in the following life sciences-related policy platforms [2]:

- **IBISA** – see details above
- **CELPHEDIA Network** (National Network for the creation, breeding of laboratory animals, phenotyping, distribution and archiving of vertebrate animal models). The Network has the following targets:
  - To develop innovative technological, standard and massively parallel approaches, in order to accelerate understanding of the genome and obtaining models of human diseases in animals.
  - In the area of functional exploration, to analyze on all aspects and on high-speed testing, the results of these modifications in a coherent way, with normal or pathological situations. Also, candidate genes are tested as a potential therapeutic target by using animal models but also using so-called humanized mouse and primate model only when necessary.
  - In the areas of distribution and storage of animal models, to improve and harmonize processes and protocols to facilitate domestic and international exchanges.
  - The industrial targets are to create innovative and quality services, available for academic and scientific community at large and attractive to private research and industry, and therefore likely to produce revenues to ensure a stable budget and support the R&D activities.
- **ISSB** (Institute of systems and synthetic biology), the constitution of a French system biology centre, following the example of other European countries. Currently at the planning stage, the institute is intended to have a strong interdisciplinary character and international orientation.
- **CICTF** (Cell and tissue functional imaging Network), a network of centres working on microscopy and imaging. Currently in its first stages, the CICTF network includes molecular and multi-molecular imaging to tissue imaging. Furthermore, photonics imaging opens up the possibility to analyze real-time networks of macromolecular interactions. Besides R&D and training activities, CICTF will provide also “service activities”: centres open to users with the availability of facilities, training, advice and support.

References

[1] Ministère de l’einsegnement supérieur et de la recherché*, Les très grandes infrastructures de recherche – Feuille de route Française – Édition 2008*, (in French), December 2008

[2] CNRS, Information provided by ERA-Instrument partner, October 2008

[3]GIS-IBISA,www.ibisa.net

Greece

The main document is the Greek Large Scale research Infrastructure [1] published by the Greek General Secretariat for Research and Technology (GSRT) in 2007.
The roadmap includes projects that comply with the general definition of Large Scale Research Infrastructure as “centres, which offer facilities, resources or services of a unique nature that have been identified by research committees to conduct top-level activities in all field”. They also must satisfy a set of scientific/strategic and technical/financial criteria [1], and the following additional criteria:

- To take or be part of National and International Collaborations;
- The be recognized at an International level as “Center of Excellence”
- The minimum level of existing infrastructure cost must be at least € 5.000.000,-

The roadmap process

The process leading to the generation of the roadmap started with a call issued in 2005 by the GRST to the research community to identify the projects of highest strategic importance. The submitted projects were assessed by three Roadmap Working Groups in the areas Physical Sciences, Biological and Medical Sciences, and Social Sciences and Humanities. Each working group, in close cooperation with field experts, classified then the proposals as either level A – existing and mature projects or level B – potentially to be included in a future call.
The roadmap is intended as a recommendation to the Greek Government to invest in large scale research infrastructures and to increase Greek involvement at the European level.

1. Life sciences vs. other research fields

The roadmap recommends 15 infrastructure projects, categorized as follows:

- 9 projects in the Physical & Engineering Sciences Group;
- 4 projects in the Biology & Medical Science Group
- 2 projects in the Social Sciences & Humanities Group.

Besides the four projects in the Biology & Medical Science Group, we can identify another 4 projects in the Physical & Engineering Sciences Group with Life Science-related applications, for a total of 8 LS-related projects. For a list of these 8 LS-related facilities see also Table 1.
In Figure 1 the required funding according to the roadmap is represented, divided per discipline. Note that the PSE group has been subdivided in LS-related and LS-unrelated facilities, in order to visualize the total percentage of LS-related funding (yellow+green areas), which amounts to 51%, for a total amount of M€ 158 recommended funding.

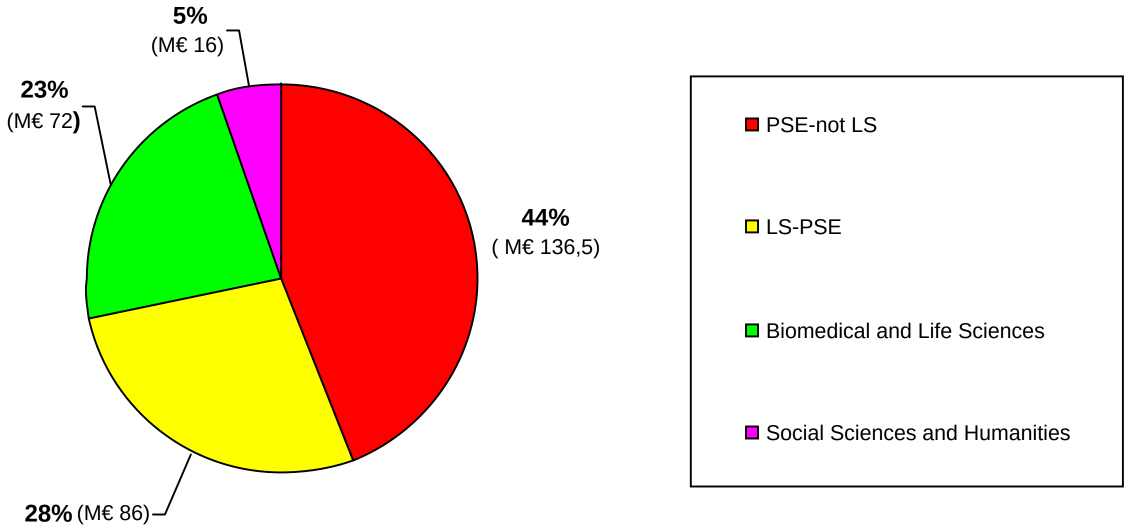


Figure 1– Subdivision per discipline of the total funding (with between brackets the corresponding value in M€) recommended in the Greek roadmap for Large Scale Facilities for a 5-year period, for construction and operation of the facilities of each group.

2. Current and foreseen status of RI in Life sciences

The roadmap does not directly address the current situation of Research Infrastructure in Greece. The ad-hoc group that generated the roadmap however directly addresses in the document the Greek Government by defining the roadmap as a serious attempt and the last chance for the Greek sciences to play a dominant role also at EU level, and pleads for financial and administrative support to the Greek scientific community to realize this. Also, it is stressed that some scientific areas, such as energy, environment and medicine, are not yet represented in the roadmap, because their communities did not respond to the GSRT call. These areas should be included in the first update of the roadmap.

Further, the view of the Presidents of the research institutes as well as distinguished scientists regarding infrastructures in life sciences in Greece are reflected in a document from the Greek Technology and Science Initiative (GTSI) [2].
Concerning the life sciences, the necessity to link Greek research to the international scene is stressed. A number of strengths and weaknesses of the Greek life sciences research field are also identified.
Main strengths are:

- The presence of competitive research groups at international level;
- The willingness of Greek researchers abroad to return to Greece, provided incentives are available.

Main weaknesses are:

- Public funding of research still disappointingly low;
- Fragmentation of activities and research;
- Almost complete absence of Greek private sector involvement in research;
- Insufficient post-graduate programs of top-level quality;
- Low social appreciation of research;
- Non-competitive salaries for researchers;
- Translation of research into products is hampered by bureaucracy and lack of infrastructures;
- No incentives to attract foreign investments in start-up companies.

As for priorities in the Life sciences, a number of research fields and technological platforms are identified, which should be immediately addressed; for all these priorities the need is stressed to favour a multidisciplinary approach, involving Biology, Chemistry, Physics and Mathematics, and global methodologies, like Systems Biology, model organisms, and –omics research fields.

3. Gaps in RI and in RI funding

Not addressed in the roadmap. From [2] it seems clear that the Greek life sciences community considers the public research funding and the availability of infrastructure insufficient (see main weaknesses in previous section).

4. National vs. international orientation

The roadmap addressed the needs for Greece-based facilities; nonetheless it is strongly EU-oriented. The roadmap generation process itself is modelled on the ESFRI model, with Roadmap Working Groups and with a selection based on criteria very similar to the ESFRI selection criteria.
Also, a significant number of the proposed projects is linked to a European project, or it is intended to be part of an international network. Finally, great stress is given in the roadmap to the necessity for the Greek scientific community to have or keep access to European large scale infrastructures, with particular to those of the ESFRI roadmap, such as for example XFEL, ELI, FAIR and PRINS.
The GTSI document [2] also stresses the need of Greece to participate to the international projects and infrastructure especially at European level. For the life sciences in particular, several Greek research groups are reportedly already participating in Framework Programs.

5. Types of RI

As can be seen in Table 1, the LS-related facilities are all but one new, and they are all distributed.

		National/international	Current/upgrade/new	Single-sited/distributed
Biology and Medical Sciences	**FUNGEN** - Functional Genomics in Model Organisms	national/ international	new	distributed
	BIOIMAGE – Imaging in Biological and Biomedical Research	national	new	distributed
	BIOANALYSIS – Evolving Analytical Methods for Studying Biological Reactivity	national	new	distributed
	TRANSBIOMED – A Translational Research and Clinical Trials Infrastructure	national	new	distributed
Phys. & eng. sciences with LS applications	**MRSEC** – Materials Research and Devices research centre	national	new	distributed
	HCEM – Hellenic Centre for Electron Microscopy	National	new	distributed
	C2T – Centre for Converging Technologies	National	new	distributed
	ALI – Advanced Laser Infrastructures	national/international	upgrade	distributed

Table 1 – List of life sciences and LS-related facilities included in the Greek roadmap

References

[1] General Secretariat for Research and Technology, *Greek Large Scale Research Infrastructures Roadmap: A 10 Years Outlook*, Athens, Greece, 2007.

[2] GTSI, *Greek Technology and Science Initiative (GTSI) in the life sciences*, draft, Feb. 2007.

Ireland

The Irish Research Infrastructure roadmap [1] has been published in 2007 by the Higher Education Authority (HEA) and Forfás, the national policy and advisory board for enterprise, trade, science, technology and innovation.
This roadmap differs from the roadmaps of the other countries analyzed in that it does not mention specific infrastructures recommended for financing or planned to be financed. It is rather a critical analysis of the strengths and weaknesses of the Irish research infrastructure, of the present gaps and future needs and gives recommendations aimed at improving the Irish research at the national level but also its positioning on the international scene.

The roadmap process
An independent international Steering Committee had oversight of the roadmap generation process. The process started with an update of the already existing database of research infrastructure, on the basis of submissions from the institutions. Also, extensive consultations were conducted with all the stakeholders, from researchers and research institutions, to funding agencies, to industry; all these stakeholders were also involved in a Stakeholders' Forum.
In particular, a special forum was organised to obtain input from research-performing industries.
At the same time, a sample of 17 sites was visited by groups of international experts.

1. Life sciences vs. other research fields

The inventory of resources carried out in the framework of the roadmap survey process allowed to estimate the distribution of researchers and infrastructure in higher-education institutions. The distribution of what is called "Research Space" occupied by researchers in higher education institution is represented in the roadmap in the form of a pie-chart [2]. Unfortunately, there are no numbers given in this qualitative pie-chart, however it is clear that Biological and Medical Sciences constitute by far the greatest field on the chart, occupying about 40-45% of the total research space. Also the inventory of existing equipment valued over 100K€ that is reported in the document consists in large part of equipment for research in Bioscience, suggesting that the Life sciences are a main field in the Irish research landscape.

2. Current and foreseen status of RI in Life sciences

In the analysis of the current status of the RI, the Life sciences status and needs are to be found in three of the considered research categories, namely:

- Biological and Medical Sciences
- Preclinical *In Vivo* Facilities
- Clinical Research Facilities

With respect to the **Biological and Medical Sciences**, in the reviewers' opinion the research in particular areas in at world top-level, however there are several issues to be solved:

- Staff: the lack of administrative and technical personnel is stressed, and the need for more long-term contracts to attract high-quality staff;
- Infrastructure: the visits to the facilities evidenced the co-existence of both new state-of-the-art infrastructure and of too old facilities, in bad conditions and with health and safety issues. For all facilities, including the new ones, overcrowding is in many cases a problem, and space allocation and management is not efficient.
- Equipment: the lack of upgrade and maintenance of the equipment, which becomes quickly obsolete; in some cases serious health and safety issues were assessed in the laboratories;
- Specific research-related needs:
    - Access to high-performance computing capacity for bioinformatics
    - Stronger linking among facilities and with hospitals for medical research
    - A generic national transgenic facility
    - Access to large animal facilities needed
    - Improved imaging facilities

Concerning the **Preclinical *in Vivo* Facilities** the following needs are stressed:

- A high-capacity national central preclinical facility or some regional medium-capacity facilities;
- More small animal facilities
- Technical support services and staff
- Increased transgenic production capabilities

Finally, the following main needs were identified for the **Clinical Research Facilities**:
- More clinical research facilities
- More technical support staff
- Need for dedicated resources for data acquisition, visualization and analysis
- Better data archiving facilities
- Need to bring clinical research facilities nearer to hospitals

3. Gaps in RI and in RI funding

The main conclusion of the International Steering Committee about the status of the Irish Research Infrastructure is that the considerable injection of funds taking place in the last few years has given impressive results in terms of the advancement of the research system. Still, due to the historical lack of investments in the past, the situation in Ireland is not yet at the same level as the rest of Europe: in this sense, it is judged as vital that the current injection of funds will be protracted also in the future.
In general, Ireland suffers from a long-term scarcity of national research investments, which resulted in a dependence of Irish research from international funding sources, a lack of strategic planning, and a “lone scholar’’ competing attitude of the research community which did not favour cooperation.
The injection of funding from about 1998, mainly through the so-called Program for Research in Third-Level Institutions (PRTLI), which alone has provided a total of 600 M€, has given a tremendous impulse to the research infrastructure. However, the level is not yet equal to that of other EU countries, and this flow of funds should continue, as one of the main conclusions of the International Steering Committee states.
As for the particular case of the biological and medical sciences, the lack of funds for the maintenance of equipments seems to be the most critical issue.

4. National vs. international orientation

Although the Irish research community has a strong history of international cooperation, the Steering Committee notices in its review that Ireland does not participate in large European organizations –for example Ireland does not yet participate in ESO despite its large astronomical research community. The advice to the government and funding agencies is to consider participation to some of these projects, at the same time providing funding in the corresponding research areas. International orientation should also be encouraged by considering the existence of international links in the evaluation of new research infrastructures.

5. Types of RI

Since the roadmap does not give a list of specific infrastructure to be financed or recommended for financing, there is also no distinction between kinds of infrastructures needed. As already mentioned, the existing RI is partly new and state-of-the-art, partly old and obsolete, and in general this latter infrastructure and equipment has to be replaced with some urgency.
With respect to the kind of infrastructure needed (distributed, virtual or centralized) the general impression from the roadmap is that the needs cover all three kinds of RI.

References

[1] Higher Education Authority (HEA) and Forfás, *Research Infrastructure in Ireland – Building for Tomorrow*, 2007.

[2] page 52 of [1]

Netherlands

The first Netherlands Roadmap has been published in October 2008 [1]. Besides indicating a number of facilities to be supported, it also gives a number of recommendations about the policy to be developed on research infrastructures, which are considered of great relevance not only from the scientific, but also from the social and economic point of views.

The roadmap process

A National Roadmap Committee has been installed by the Minister of Education, Culture and Science in July 2007, with the task to draw up a roadmap by selecting and prioritizing RI projects on the basis of a number of selection criteria and keeping also into account the developments in RI policy in Europe, in particular within ESFRI.

The committee worked on:

- the 35 projects of the ESFRI 2006 roadmap;
- submissions from the Dutch scientific community, who was asked by the committee to send proposals for projects to be included in the roadmap. A total of 56 submissions were received.

Eleven selection criteria were considered for the analysis, including the six criteria used for the ESFRI roadmap selection.

For the ESFRI projects also the Dutch (need for) involvement has been considered, more specifically:

- whether Dutch research groups had expressed interest in participating
- whether money and personnel has been already invested in the project
- which ESFRI projects is strategically most convenient for the Netherlands to invest in, in the short-term.

The committee gave to each ESFRI-facility a “participation level” as score:

- A: highest participation level desirable, i.e. hosting of the facility
- B: participation in the development of the facility
- C: utilization of the facility

As for the submitted proposals, they were assessed by the committee with the assistance of the Netherlands Organization for Scientific Research (NWO) and of the Agency of the Dutch Ministry of Economic Affairs (SenterNovem). Of the 56 originally submitted proposals, 16 were selected to be further elaborated, which were reduced to 13 after peer review.

At the end of the process, 25 facilities were selected for inclusion in the roadmap, 16 of which are ESFRI facilities while 9 are from the submitted proposals.

1. Life sciences vs. other research fields

The 25 facilities of the Dutch RI roadmap are divided in the categories:

- Social Sciences and Humanities
- Physical and Technical Sciences
- Environmental Sciences and Energy
- Medical and Life sciences
- E-Science

Table 1 lists facilities included in the Dutch RI roadmap for the category Medical and Life sciences and for the LS-related part of Physical and Technical Sciences. Five facilities were selected in the first category, while the LS-related facilities are two. For the sake of completeness, it has however to be pointed out that, in the selection of facilities, the committee has also tried to have more or less the same number of facilities in the different categories.

Eight out of the 25 projects are recommended by the committee for financial and political support within short term: the LS-related ones among these projects are shown in red in the Table.

Medical and Life sciences	BBMRI	Participation level A
	EATRIS	Political support
	EURO-BioImaging	
	Mouse Clinic for Cancer and Aging Research (MCCA)	
	Netherlands Centre for Electron Nanoscopy (NeCEN)	
Physical and Technical Sciences	European X-FEL	Participation level B/C
	European Spallation Source	Political support

Table 1 - LS-related facilities listed in the Dutch roadmap.

2. Current and foreseen status of RI in life sciences

Not addressed in the roadmap.

3. Gaps in RI and in RI funding

The roadmap does not address directly gaps in RI and RI funding specifically for the life sciences, however the importance of proper funding for Research Infrastructure in general is stressed. The committee has the following recommendations:

- funds for RI should be available on a structural basis; this is actually being realized in the Netherlands, through the assignment of additional budget to NWO and through the injection of funds from the Dutch assets from natural gas ("FES");
- public-private partnership should be strengthened;
- also, the possibilities for EU funding beyond the FP7 should be explored;
- the synergy among European Programmes should be strengthened;
- financing through the EIB-EU should be better exploited, for example through the "Risk Sharing Finance Facility" (RSFF).

4. National vs. international orientation

The Dutch roadmap is strongly oriented towards the international scene, as testified by the inclusion of the ESFRI facilities in the analyzed projects, and by the choice of criteria, partially similar to those used in the ESFRI Roadmap selection.
The importance of following the international developments is also a recurrent theme in the roadmap, as indicated by the recommendations about European possibilities for funding, for cooperation, and access to infrastructures mentioned above.

5. Types of RI

No particular mention is given in the roadmap about preferences for new RI's versus existing ones; both kinds of facilities appear in the list. The same holds for the type of RI's, both single-sited and distributed are considered.

Additional documents

Immediately after the publication of the Dutch roadmap, the Minister for Science, Culture and Education asked NWO and SenterNovem to advise on the funding of the eight research infrastructures indicated with high priority by the Roadmap committee [2]. Based on an available budget of 63 M€, NWO and SenterNovem produced a ranking of the eight facilities, advising the funding of five of them. BBMRI, the only LS project of the eight, is second in the list, with the highest amount of advised funding (22,5 M€), while E-XFEL is one of the three projects for which the advice is not to fund.

References

[1] Commissie Nationale Roadmap Grootschalige Onderzoeksfaciliteiten, *Nederlandse Roadmap Grootschalige Onderzoeksfaciliteiten* (in Dutch), Amsterdam, October 2008.

[2] NWO & SenterNovem, *ESFRI Advisory Report* (in Dutch), The Hague, November 2008.

Norway

The Research Council of Norway (Forskningsrådet) has published in February 2008 a National Strategy for Research Infrastructures for the period 2008-2017 [1].
The strategy has a 10-years horizon, and consists of two parts:

- an overview of the developments in Europe and the status of Norway;
- the strategic priorities for research, innovation and industrial development, including the needs for research infrastructure reported from R&D institutions; this part is expected to be revised one to two times during the coming decade.

In the intentions of the Research Council, the strategy should be accompanied by a separate, third part, an action plan. The plan should be a three-year and revised annually to be consistent with the Research Council allocated budget, and with budget and commitment related to the earlier grants.

In the document, the following Research Infrastructure is considered:

- All kinds of scientific equipment, from basic equipment, that must be available at all institutions, to advanced equipment for special research;
- Large-scale research facilities, which are larger laboratories or research installations;
- E-infrastructure;
- Scientific databases and scientific collections

The roadmap process

For investments in large-scale infrastructure or in international participation to research facilities, the emphasis lies in two main aspects, namely

- the foreseen contribution to research at both the national and international level;
- the opportunities it offers in high-priority research for Norwegian researchers, who cannot otherwise participate.

The Norwegian Research Council asked in May 2007 the institutions to assess the need of investments in new - or in the upgrade of - existing large-scale research infrastructure in Norway, for investment costs greater than 30 million, as well as the need for investments in international cooperation for research infrastructure and a list of the projects on the ESFRI roadmap they are involved in. Institutions were also asked to prepare a priority list of research infrastructures, out of the ESFRI projects, that they judge important to have realized in the coming 4-year period.
The facilities included in the document are those rated by the Norwegian Research Council as mature, in the sense that a decision about the investment can be taken within 1 to 2 years.
It is stressed however that any allocation of funding for RI must occur through the open competition system, which is open also to RI's not included in the roadmap. In this sense, inclusion in the roadmap does not imply any commitment about funding. For an explanation if the RI funding system see also section 2.

1. Life sciences vs. other research fields

Priority areas are classified in three categories, plus "e-Infrastructures" and "Scientific Databases and Collections" which are considered as separated areas because of their multidisciplinary character:

- Structural:
    - Internationalization
    - Basic research
    - Research innovation
- Thematic:
    - Energy and the Environment
    - Food
    - Ocean
    - Health
- Technology areas:
    - ICT
    - New materials and Nanotechnology
    - Biotechnology

- e-infrastructure
- Scientific databases and collections

The list of national facilities compiled on the basis of the input from R&D institutions and following the procedure explained in the previous section, contains 54 national projects and facilities. Each of these projects has been classified under one or more of the priority areas listed above. Of these projects, about 20 can be considered as life sciences (related) projects as they are related to Health, Biology or Biotechnology, and/or scientific databases and collections. Notice that with respect to the category "Material Technology and Nanotechnology", the biology related research is related to the synchrotron and neutron sources and to free electron laser sources: as this research takes place at international facilities, there is no need for such RI's mentioned in this category, but only the need for participation at the international level is stressed.

2. Current and foreseen status of RI in life sciences

For each priority area identified through the survey among the Norwegian R&D institution, a number of challenges and related need for infrastructures for the next years has been identified.

Health

Challenges

- o Increased life expectancy brings higher rates of chronic and complex diseases, of mental disorders and cancer
- o Increased mobility across borders increases the risk of infectious diseases.
- o Medical research is increasingly linked with the commercial market, in fields such as biotechnology, chemical technology for diagnosis and treatment, medical imaging.

Need for infrastructures

- o There is need for better use and for improving of bio banks and health records. For this purpose laboratories may need more high-throughput analysis equipment.
- o Imaging technology is rapidly developing with the use of technology such as ultrasound, CT, MR and PET scanners.
- o Medical research needs for expensive equipment include chromatographers, mass spectrometers and NMR.
- o Translational research is another important field with great potential for innovation and the need for advanced infrastructure

Biotechnology

Challenges

Biotechnology and biology are designated by many as the 21st century's most important areas in science. The combination of basic biological research, new technology and new methods will have impact in many fields from diagnostics and analysis, medicine and pharmaceuticals, to marine activities, aquaculture and food production.

Norwegian research in this area is of top quality at international level; still the feeling is that the competitiveness is very high.

Need for infrastructures

- o Need to continue the ongoing development of the system of national technology platforms in the key fields of biotechnology.
- o Better logistics systems and data warehousing, and investment in equipment for the automated production of biobank material for research.
- o Better exploitation of biobanks through investments in equipment for large-scale genome analysis and by increasing the capacity for bioinformatics and statistical analysis.
- o More investments in System Biology, which involves the handling of huge amounts of data and requires advanced screening equipment (High Throughput Screening (HTS)) and capacity to analyze proteins, genome and metabolic products.
- o Need for certification of the established technology platforms, a costly process that is necessary among others to allow their use for developing new pharmaceuticals.

Scientific databases and collections

Challenges

The major challenge is to make the data available in secure databases and collections in a form and organization that they can be used in research both nationally and internationally.

Need for infrastructures

- o Need for institutions with special expertise on data archiving and handling, and taking care of the economic, legal, technical and administrative barriers to the sharing of data.

3. Gaps in RI and in RI funding

According to [1], in the period 1995-2005, the total R & D investments increased from approximately 16 billion to approximately 29 billion in current Norwegian Krone (NKO). Measured in fixed 2000-NKO, this corresponds to an increase of nearly 36 percent.

In the same period the total capital investment of scientific equipment increased from approximately 1.2 billion to about 1.4 billion in current NKO's. Measured in fixed 2000-NKO's, this corresponds to an increase of 22 percent. Measured in fixed 2000-NKO's, about 4 percent of growth in the total R&D investment went to increased investment in scientific equipment and instruments.

Lack of advanced scientific equipment has been a problem for Norwegian research in many years. The investment in advanced scientific equipment in the R&D sector has been estimated in 2004 by the Research Council to 2.6 billion up to 2010. This sum regards equipment with cost under 100 million NOK and is intended for one-third for the replacement of outdated equipment, and for two-thirds for new equipment. As for equipment with cost above 100 million NOK, the need for investments has been estimated at 3.2 billion NOK.
The need for funding is particularly stressed for:

- e-infrastructure, for which nowadays continuous upgrade is needed;
- scientific databases and collections; Norway has high reputation for databases and collection especially in the health, environmental monitoring and social sciences, however in some fields there is still need for improvement.

The estimated requirements for all types of research infrastructure over the coming years are summarized in the table below, which is a translation of the table at page 9 of [1].
As can be deduced from the table, the estimated needs for investments costs amount to 11 billion NOK over ten years. In addition, annual operating costs for large-scale research facilities in Norway and member fees for participation in the new international research infrastructures will increase through the period to approximately 700 million NOK.

Table 1 - Estimated needs over the next ten years
(this table is a translation of table on page 9 of [1])

Type of infrastructure	Investment (millions NOK)	Operations* (millions NOK)
Investment in scientific equipment	2600	--
Investment in national large-scale Research infrastructure	5500	550
International cooperation on Research infrastructure	1200	120
Scientific databases and collections	800	--
e-Infrastructure	700	--
Total	**10800**	**670**

* Annual operating costs are conservatively estimated to be at 10 percent of the investment cost. Operating costs will rise through the period in line with the investment and eventually be at the level suggested here

The roadmap recommends further to ensure reliable long-term financing by establishing a government fund for research infrastructure, with a start capital of 20 billion NOK, with a 800 million NOK yearly budget for investment - including operation costs - in new as well as in existing RI. It is also recommended to distribute 25 percent of the annual return as earmarked allocations over the budgets of the R&D institutions (universities, university colleges and independent research institutes), while the remaining 75 per cent is channelled through the Research Council.

As for the allocation process for the funds for large scale infrastructure, the Research Council should be responsible for applications for funding in the range of 2-200 million NOK. An open process is advised, where applications are assessed by an interdisciplinary scientific committee with expertise at high international level. Based on the recommendations of the advisory committee and on the considerations of the relevant Council Division Board, the administration prepares a recommendation to be submitted to the Council General Board.
Recommendations for funding over 200 million NOK and long-term commitments for international cooperation should instead be submitted by the Main Board to the relevant Ministry for approval.

4. National vs. international orientation

The importance of keeping access to the most sophisticated research infrastructures outside Norway is stressed, and indeed Norway cooperates in many international RI projects. Condition for membership to the main international facilities is of course that there are enough prominent scientists and active research in the field to justify the membership costs.
With respect to the international scene, Norway participates in several major projects, among which the LS-related are ESRF, EMBL and IARC, not counting the ESFRI projects.
As for these latter, Norway participates in 11 ESFRI projects that are currently in the preparatory phase. The LS-related among them are:

- EATRIS
- BBMRI
- MAX_lab
- DESY
- ESS (supporting Sweden as candidate host)
- ILL

5. Types of RI

Not addressed specifically in the roadmap

References

[1] Norges forskningsråd, *Verktøy for forskning - Nasjonal strategi for forskningsinfrastruktur (2008 – 2017)* (in Norwegian), February 2008.

Spain

The Roadmap of the Singular Scientific and Technological Infrastructures (ICTS) [1] is the result of the agreement between Spanish regions and the state to address the progress of science and technology development in Spain, and is part of the national science policy programme, called INGENIO 2010 [2]. The requirements that define the ICTS provided for the preparation of the roadmap are the following:

- they are unique, in terms of their design and construction characteristics or because or their use and applications during exploitation;
- they are tools for high-level science at the frontier of knowledge, for technological development and development of pilot innovative technological processes, to be used later in different areas of industrial production;
- the investment required for construction and operation of such a RI are too high for the budgets of the R&D area of science in which it will operate;
- their construction and maintenance brings dynamic in the economy and in the involvement of enterprises;
- can be located at a single point or distributed in several places geographically, but in any case, they should be placed where a critical mass of research commensurate with the level of the facility;
- they must be open to researchers and technologists both at national and international level, with the establishment of a protocol for public access.

The roadmap process

The ICTS are selected by the Inter-Ministry Commission for Science and Technology (CICYT), the sole body entitled to award the ICTS label. The procedure started with consultations of the research and enterprise communities, and continued in 2006 with meetings with the Autonomous Communities of Spain. This has resulted in a long list of facilities, which have then been further short listed according to the criteria mentioned above and to the excellence and potential of the research community of the region.

1. Life sciences vs. other research fields

The national research infrastructures classified as "ICTS" in the updated version of the roadmap [1] are divided in 8 categories, as shown in figure 1. Notice that in the list the European Spallation Source is considered too, under "Microscopy and particle physics" since Bilbao is one of the candidate host sites.

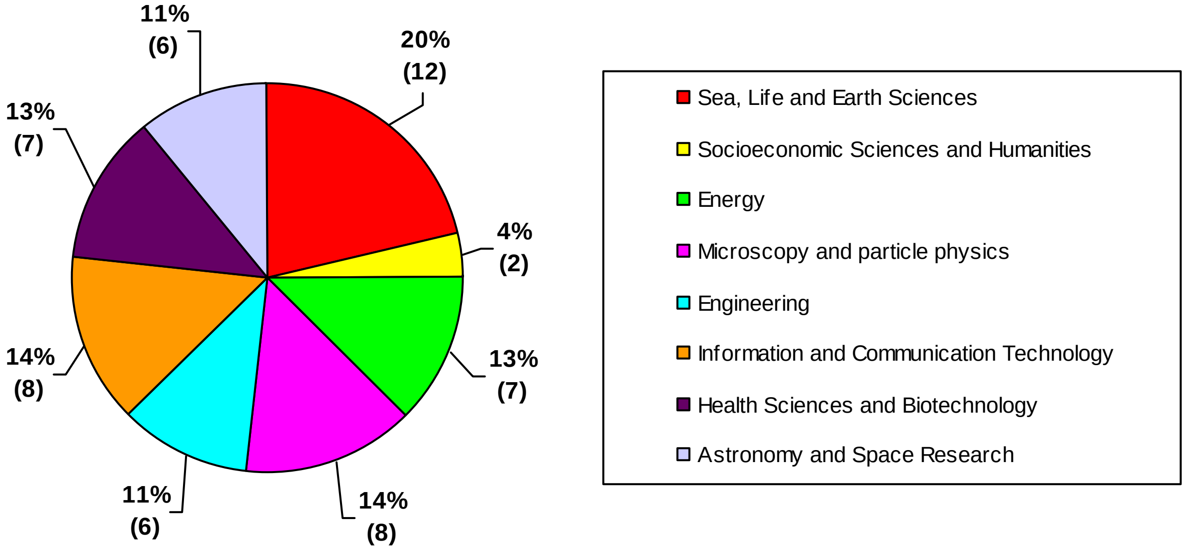


Figure 1 – Percentages (with in brackets absolute numbers) of recommended facilities for each discipline as given in the Spanish roadmap 2008.

For the life sciences, the RI's included in the roadmap are shown in Table 1, for a total of 14 (23% of all ICTS):

		National / international	Current / upgrade / new	Single-sited / distributed
Microscopy and particle physics	**National Accelerators Centre, CNA**	national	current	single-sited
	European Spallation Source (if in Bilbao)	international	new	single-sited
	Molecular Imaging Facility (País Vasco)	national	new	single-sited
	Ultraintense Pulsed Lasers Facility	national	new	single-sited
	Advanced Microscopy Facility (Aragón)	national	new	single-sited
	Advanced Microscopy Laboratory (Madrid)	national	new	single-sited
	ALBA Synchrotron	national	current	single-sited
Health Sciences and Biotechnology	**Medical Physics Centre (Comunidad Valenciana)**	national	new	single-sited
	Safe Biological Facility of CISA	national	current	single-sited
	Proteomic Structural Biology installation, linked to the ALBA Synchrotron	national	new	single-sited
	Medical Image Facility and Diagnose (Navarra)	national	new	single-sited
	Medical Image Treatment Facility (Madrid)	national	new	single-sited
	Laboratory of Nuclear Magnetic Resonance (Cataluña)	national	current	single-sited
	"Mouse-clinic" Platform	national	new	single-sited

Table 1 – LS-related facilities included in the Spanish roadmap

2. Current and foreseen status of RI in life sciences

Not addressed in the available documents

3. Gaps in RI and in RI funding

Possible gaps in RI and RI funding are not addressed in the roadmap and other available documentation.
The funding for research infrastructures is provided through the National R&D plan, which finances the maintenance and upgrading of the existing ICTS through yearly calls. The budgets were in the order of 5 t o 7 M€ per call (years 2005, 2006 and 2007) [3].

4. National vs. international orientation

Besides listing the National RI's with high priority in the next years, the Spanish roadmap gives also an overview of the international facilities to which Spain participates. Among them, the following RI's with life sciences applications are mentioned:

- EMBL
- ESRF – Spain contributes for 4% of its total budget; in addition, Spain owns two beamlines, one of which for soft matter studies.
- ISIS
- ILL
- X-FEL

5. Types of RI

Of the ICTS presented in the roadmap [1], 24 are new RI's, one – the European Spallation Source – is mentioned as ''project'', while the remaining RI's are existing or under construction. As can be seen in Table 1, the majority of the LS-related facilities are new; all of them are single-sited.

References

[1] Ministerio de educacion y ciencia, *Mapa de Instalaciones Científicas y Técnicas Singulares,* 2008, in Spanish

[2] Ministerio de educacion y ciencia, *Fondo Estratégico de Infraestructuras Científicas y Tecnológicas* http://www.ingenio2010.es/contenido.asp?menu1=3&menu2=0&menu3=&dir=./02_instrumentos/02_Caracteristicas/01_CONSOLIDER&id=En

[3] Ministerio de educacion y ciencia, *Singular scientific and technological infrastructures (ICTS)*, 2007, ftp://ftp.cordis.europa.eu/pub/esfri/docs/spanish-singular-scientific-infrastructures_en.pdf

[4] Comisiòn Interministerial de Ciencia y Tecnología, *Estrategia Nacional de Ciencia y Tecnología*, Fundación Española para la Ciencia y la Tecnología (FECYT), 2007

Sweden

The most recent edition of the Swedish roadmap for research infrastructure, “The Swedish research council’s guide to infrastructure” [1] was published at the beginning of 2008. The roadmap is a joint effort of the Swedish Research Councils with the Swedish Governmental Agency for Innovation Systems (VINNOVA), and is intended as an inventory of the long-term needs for research infrastructure in the different research fields.
The research infrastructures considered in the roadmap satisfy the following criteria:

- are of national interest
- offer potential for world-leading research
- are too extensive for single groups
- include long-term planning
- are accessible to all researchers

The roadmap process

A Committee for research Infrastructures (KFI) was established by the Board of the Swedish Research Councils in order to carry out the task.
The KFI and a number of subcommittees of specialists in the different areas were involved in extensive consultations through a seminar and a web-forum with universities and university colleges, and various research groups. Additional input to the process came from the discussions on the Swedish participation to the preparatory phase of a number of ESFRI projects in 2007 and from studies carried out by the research councils following the publication of the first edition of the roadmap. The research councils reviewed and commented then on both the first edition and on the draft second edition of the roadmap.

1. Life sciences vs. other research fields

Six research areas are considered in the roadmap, plus the Swedish Synchrotron MAX IV, which is considered apart due to its interdisciplinary character. Figure 1 presents the estimated needs for funding for each of these areas as advised in the roadmap.

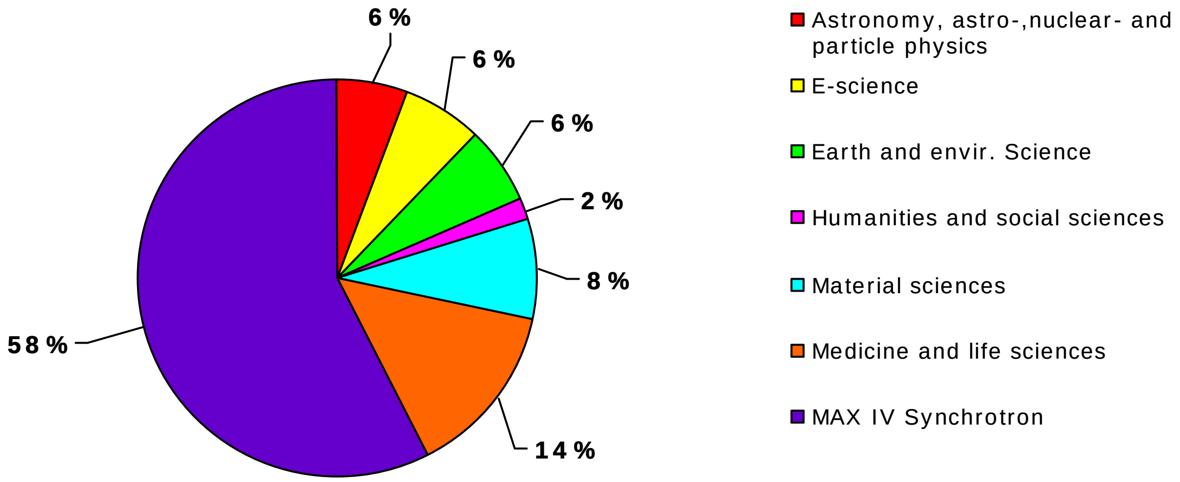


Figure 1 – Estimated needs, above current budgets, for new Swedish investment in research infrastructures according to the 2008 Roadmap.

Five out of 25 infrastructure projects recommended for future investments are in the category “Medicine and life sciences”. Four other facilities recommended for investments under Materials Sciences are also extensively used in Medicine or life sciences.
The estimated need of investment up to 2012 in Medicine and Life Science is the highest with 400 billion SEK, the next higher is 220 billion SEK for Materials Sciences (which benefits also Medicine &

life sciences). To this has to be added the LS-related application of the Swedish Synchrotron, which, with 1610 billions SEK, constitutes by far the largest investment.

2. Current and foreseen status of RI in life sciences

The following trends in the life sciences are identified:

1) The increasing importance of research at the boundary between medicine and biology, chemistry and physics. Particularly important are in this sense the fields of comparative and functional genomics – Sweden itself has a strong reputation in plants research and genomics, and in research with animal models.
2) The need to strengthen translational research, in order to link fundamental research to clinical applications and healthcare. Sweden has large population and disease registries, and integration of this data with biological databases would further improve the already strong position of the country in this field at the international level.

3. Gaps in RI and in RI funding

With respect to research infrastructure, the trends above translate into the necessity to a broader range of data (like genetic, biological or medical databanks) and instrumentation (such as for example synchrotrons, lasers and clean rooms).
Also, investments are required in large-scale biomedical research infrastructure as well as changes in organization, education and career possibilities for researchers within the health service.

As for RI funding,

- *For Genomics, proteomics, biotechnology and imaging:*
  The national IR is being financed by means of different, time-limited investments, such as for example the SSF and the Wallenberg Foundation. To keep the pace internationally and to allow continuity and long-term development of expertise in LS research it is recommended
  1) to have long-term investments policy for national resources
  2) to participate in international projects, particularly important for high-level technological development and for continual rejuvenation
- *For Medicine:*
  In medicine long term financing consists mainly of financing by county councils to university hospitals. The progress in medicine research and its growing links to other disciplines require better organisation and more financing to cover all the aspects related to medical research, such as imaging, computing, databases, documentation, legislation, etc.

4. National vs. international orientation

Participation of Swedish research to European RI projects is seen as very important in order to keep a high research level in Sweden and the participation to the scientific and technological outcomes of such facilities. The aim is to host international facilities (Sweden is candidate host for ESS), or to have, for distributed facilities, one of the facility centres located in Sweden.

To strengthen the position of Sweden at the international level, the cooperation of the Scandinavian countries in the so-called Nordic Cooperation is also seen as a relevant instrument.

The international orientation of the Swedish research strategy is recognizable in the support to the infrastructure projects of the first ESFRI roadmap.
In 2007, the Swedish Research Council has focused its attention on the 35 RI projects selected for the first ESFRI roadmap, and decided to support seven of them as co-applicant, and other eight with a letter of support. A considerable part of these projects are life sciences projects (ELIXIR, LifeWatch, BBMRI, EATRIS, Infrafrontier) or have applications in the LS (ESS, XFEL, IRUVX-FEL).

Swedish centres are encouraged to link to international projects to constitute a national coordination node. Examples of national infrastructure linked to the international ESFRI projects:

- The already planned **BILS** (Bioinformatics infrastructure for Biosciences), project is intended to coordinate research and education in bioinformatics at the national level, and at the same time to become the Swedish node of the ELIXIR infrastructure.
- The Swedish national Biobank Information Management System, **BIMS,** located at Karolinska Institute, is already integrated in several European Biobanks and is also included in the planned **BBMRI**.
- Also one of the six centres constituting **EATRIS,** the distributed infrastructure for translational research, will be located at Karolinska Institute.
- The **SweIMP** network (Swedish Mouse Phenotyping facility), is intended to coordinate at national level the research on mouse models in Sweden and to serve as a node to Infrafrontier (European Infrastructure for Phenotyping and Archiving of Model Mammalian Genomes)

Besides the above mentioned ESFRI projects, Sweden participates in

- EMBL and EMBC
- IARC (International Agency for Research on Cancer, WHO)
- INCF (International Neuroinformatics Coordinating Facility)
- MIMS (Laboratory for Molecular Infection Medicine Sweden): the Umeå University serves as a node for EMBL together with universities of Helsinki and Oslo in the ''Nordic EMBL partnership for Molecular Medicine''.

Concerning the Research Infrastructure in the Materials Sciences with life sciences application, the projects appearing in the roadmap are:

- **ESRF**, for which Sweden has access mainly for protein crystallography and structural biology
- the national synchrotron **Max-lab**; the design work for next generation facility MAX-IV was recently concluded.
- **X-FEL**, Sweden participates with a contribution of at least 12 M€
- **ILL** and **ISIS**; for ILL the Swedish Research Council has a contract granting access to 1,5% of the beam time.
- **ESS**, Sweden proposes Lund as location for the facility
- national network of clean rooms **Myfab**
- **IRUVX-FEL** (network of national free electron lasers, each one specialised in a different field of study): Sweden participates with a free laser in the second phase of **MAX IV**

5. Types of RI

Table 1 shows the characteristics of the roadmap facilities: as already shown in the previous section, most facilities are either international (including European), or national but linked to international projects. As for the number of new vs. existing facilities, it is practically equal, and the same can be said about the number of single-sited versus distributed ones.

Table 1 – Facilities of the Swedish roadmap

		Geographical Coverage	Current / Upgrade / New	Single-sited / distributed
Medicine and Life Sciences	**EMBL**	European	Current	Distributed
	IARC	International	Current	Single-sited
	MIMS	Swedish	Current	Single-sited
	BILS/ELIXIR	Swedish/European	New	Distributed
	Biobanker/BBMRI	Swedish/European	New	Distributed
	EATRIS	European	New	Distributed
	National core facilities in functional genomics, etc	Swedish	New	Distributed
	SweImp/Infrafrontier	Swedish/European	New	Distributed

Materials Science	**ESRF**	European	Current	Single-sited
	ILL	European	Current	Single-sited
	ISIS	European	Current	Single-sited
	MAX-lab	Swedish	Current	Single-sited
	MyFab	Swedish	Current	Distributed
	ESRF Upgrade	European	Upgrade	Single-sited
	ESS	European	New	Single-sited
	ILLL 20/20	European	Upgrade	Single-sited
	IRUVX-FEL	European	New	Distributed
	MAX IV	Nordic	New	Single-sited
	XFEL	European	New	Single-sited

References

[1] Vetenskapsradet, *Swedish research council's guide to infrastructure - 2nd edition (2007)*, Vetenskapsradets rapportserie, 2008.

United States

The Office of Science of the US Department of Energy has published in 2003 a plan for national facilities, *"Facilities for the Future of Science- A Twenty-Year Outlook"* [1], in which 28 facilities were listed and prioritized for funding according to their scientific priority and technological readiness. This roadmap was followed in 2007 by an update on the status of the facilities [2].

The roadmap process

The preparation of the roadmap started with a consultation of the Associate Directors of the Office of Science – the Office of Science has an Associate Director for each of its scientific programs: Advanced Scientific Computing Research, Biological and Environmental Research, Basic Energy Sciences, Fusion Energy Sciences, High Energy Physics, and Nuclear Physics. Each Associate Director was given a funding "envelope" and was asked to list the facilities needed for world scientific leadership in their programs up to 2023, considering their estimated research budget as well as the major facility planning, construction and operation costs. The consultation led to a list of 46 facilities, which were then submitted to the scientific programs Advisory Committees. The committees, composed by people from the university (the majority), DOE laboratories, industry, and other governmental organizations, were asked to analyse the list provided by the own Associate Director and if they judged necessary, to eliminate and/or add facilities – the only requirement in doing this being a minimum investment needed of USD 50 million. The committees were also asked to rank then the facilities of the list according to two criteria:

- the importance of the science that the facility would support: divided in highest, secondary and hard-to-asses scientific importance;
- the readiness of the facility for construction, divided in "near-term", "mid-term" and "far-term"

The result was a list of 53 facilities arranged in a matrix according to the two criteria and six categories. The number of facilities was then prioritized by the Director of the Office, according to his assessment of their scientific promise and their fit within the Department's missions. Taking into account all the costs of the Office Science base research programs and other responsibilities, and the funding envelope until 2023, the process resulted in the selection of 28 projects.

The roadmap update [2], published in 2007, describes the status of the projects by the end of the fiscal year 2007 (30 September 2007) and the projected status by the end of the fiscal year 2008 (30 Sept. 2008).

1. Life sciences vs. other research fields

Table 1 shows the foreseen status for September 2008 of the DoE roadmap [1] facilities as shown in the Interim Report of 2007 [2]. In table, only the life sciences-related facilities are considered (11 out of 28). The facilities are grouped in near- mid- and far-term priorities and also in priority groups (2nd column).
The only life sciences infrastructures in the roadmap list are the four facilities shown in red, which in the update are grouped as Bioenergy Research Centers. DoE provided funds for three Bioenergy Centers, for $25 million each for five years. Originated from the Office of Science's Genomics GTL program, the centres have a clearly different focus, as they are oriented towards the bioenergy area.

The DoE roadmap focuses on (then) new projects and updates; however the Department of Energy itself maintains and operates a number of large facilities in all research fields in the U.S.

Within DoE, the Office of Biological and Environmental Research is responsible for a.o. the following User Facilities:

- DOE Joint Genome Institute, which unites the expertise of five national laboratories—Lawrence Berkeley, Lawrence Livermore, Los Alamos, Oak Ridge, and Pacific Northwest—along with the HudsonAlpha Institute for Biotechnology to advance genomics in support of the DOE missions related to clean energy generation and environmental characterization and cleanup. JGI is operated by the University of California for the U.S. Department of Energy. The DOE JGI's largest customers are the DOE Bioenergy Research Centers (BRCs), which were launched in 2007 to accelerate basic research in the development of next generation cellulosic biofuels.

- Environmental Molecular Sciences Laboratory (EMSL) located at the Pacific Northwest National Laboratory

The Office of Basic Energy Sciences operates a.o. the synchrotron radiation light sources:

- National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory in Upton, NY
- Stanford Synchrotron Radiation Laboratory (SSRL) at Stanford Linear Accelerator Center in Stanford, CA
- Advanced Light Source (ALS) at Lawrence Berkeley National Laboratory in Berkeley, CA
- Advanced Photon Source (APS) at Argonne National Laboratory in Argonne, IL
- Linac Coherent Light Source (LCLS) — also in the roadmap - under construction at Stanford Linear Accelerator Center in Stanford, CA
- National Synchrotron Light Source-II (NSLS-II) — also in the roadmap - under construction at Brookhaven National Laboratory in Upton, NY

	Priority	Facility	Status
Near-term	Tie for 3	Linac Coherent Light Source (LCLS)	X-ray free electron laser in construction at the Stanford Linear Accelerator Center
	Tie for 3	Protein Production and Tags	grouped and redefined as **Bioenergy Research Centers**
	Tie for 7	Characterization and Imaging	
Mid-term	Tie for 14	Analysis/Modeling of Cellular Systems	
	Tie for 14	Whole Proteome Analysis	
	Tie for 14	Spallation Neutron Source (SNS) 2-4 MW Upgrade	Possible completion in 2012
	Tie for 14	Spallation Neutron Source (SNS) Second Target Station	In R&D development phase
Far-term	Tie for 21	National Synchrotron Light Source II (NSLS-II)	Start of construction in fiscal year (FY) 2009, completion scheduled in FY 2015.
	Tie for 23	Advanced Light Sources (ALS) Upgrade	Under study
	Tie for 23	Advanced Photon Source (APS) Upgrade	Under study
	Tie for 23	High Flux Isotope Reactor (HFIR) Second Cold Source and Guide Hall	Under study

Table 1 - Foreseen status of life sciences-related facilities in the DoE 20-year Outlook, as given in the 2007 Update [2]

2. Current and foreseen status of RI in life sciences

Not addressed in the roadmap

3. Gaps in RI and in RI funding

Not addressed in the roadmap

4. National vs. international orientation

The roadmap focuses on national projects, the only exception being ITER – which has the highest priority of all the projects.

5. Types of RI

As already mentioned, the roadmap focuses on new projects and on upgrades of existing facilities. The synchrotron radiation light sources are of course single-sited, as for the Biology laboratories, the Bioenergy Research Centres, the JGI and the ESML, these can all be considered as distributed facilities.

Other strategy documents

National Science Foundation Facility Plan

The National Science Foundation (NSF) publishes each year a facility plan [3] describing the NSF investments in large scale infrastructure. NSF covers all fields of fundamental science and engineering except for Medical Sciences, and has a directorate for Biological Sciences [3] and within that a Division of Biological Infrastructure [4].

The NSF Facility Plan mentions only one facility which is life sciences-related, namely the National High Magnetic Field Laboratory (NHMFL). The NHMFL is operated for NSF by a consortium of three institutions, and the annual support for operations and maintenance amounts to US$ 26.5 million.

However, as stated in the NSF Budget Request to the Congress for the fiscal year 2009 [5], NSF is responsible for 67% of the total federal funding to Academic Institutions for fundamental research in non-medical biological research.

Most of the infrastructure-related funding is handled within the Division of Biological Infrastructure (DBI) which for 2009 has requested a budget equal to the 2008 budget, amounting to about US$ 87 million, about US$ 56 million of which are to be dedicated to fellowships, instrumentation, infrastructure improvements and research grants. Concerning infrastructure, the DBI funds projects that are a) beyond the means of single organizations and b) inter- and multi-disciplinary. The DBI priorities for RI are:

- cyber infrastructure for all applications in biology
- access to and development of the newest biology instrumentation
- improvements to biological collections

Additional funding for infrastructure in the life sciences is provided also by the Emerging Frontiers Division (EF), which encourages synergy among research in different disciplines by a.o. offering infrastructure grants. Centres financed through EF, for a total of about US$ 53 million, are:

- Plant Science Infrastructure Collaborative
- Centre for Environmental Implications of Nanotechnology
- Centre for Research at the Interface of the Mathematical and Biological Sciences
- National Ecological Observatories Network (NEON)

NIH - National Centre for Research Resources (NCRR)

Of course no overview of the life sciences research policy of the United States would be complete without considering NIH, under which the most part of the medical and medical-related research (e.g. in chemistry, biology, physics, etc…) falls.

NIH has no research infrastructure roadmap or strategy. Each institute of NIH has an own budget, mainly dedicated to research project grants, but with a small portion for research infrastructure.

An exception to this is the National Centre for Research Resources (NCRR), which has the responsibility of the infrastructure related to clinical and translational research at NIH. The NCRR funds are for the most part designated for centre grants for research infrastructure. In the fiscal year 2008, a budget of US$760 million was distributed as centre grants, and US$69 million for research grants. The centre grants cover specially adapted research facilities, instrumentation, training, animal models and expertise to more than 30.000 NIH-funded biomedical investigators [6].

The NCRR strategy focuses on four main areas [7]:

- clinical research
- biomedical technology
- comparative medicine
- research infrastructure

The area research infrastructure refers actually mainly to the development of infrastructure in institutions and states which are historically less successful in biomedical sciences. When it comes to research infrastructure, all the four main areas include the development of facilities for basic, translational and clinical research in different biomedical research fields.

Finally, the so-called NIH roadmap for Medical Sciences is also used for financing among others (but not specifically) research infrastructure. Despite what the name may suggest, the NIH roadmap is not a strategy document, but a funding scheme for high-priority research, which does not fit into the existing institutes' research lines. This cross-institutes funding is intended to enable research on a fast track on areas of emerging importance, defined by the NIH Director [8].

References

[1] U.S. Department of Energy, *Facilities for the Future of Science- A Twenty-Year Outlook*, November 2003

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[3] http://www.nsf.gov/dir/index.jsp?org=BIO

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[5] NSF, *Fiscal Year 2009 NSF Budget Request to Congress*, http://www.nsf.gov/about/budget/fy2009/pdf/17_fy2009.pdf

[6] National Centre for Research Resources (NCRR), *NCRR Strategic Plan 2009-2013. Translating Research fro Basic Discovery to Improved Patient Care*, NCRR-NIH, 2008.

[7] National Centre for Research Resources (NCRR), *NCRR Strategic Priorities 2009-2013. An Action Plan for the Future*, NCRR-NIH, 2008.

[8] http://nihroadmap.nih.gov/

United Kingdom

The main strategy document on Research Infrastructures is the Research Councils' UK Roadmap, the most recent version of which has been published in July 2008 [1].
The roadmap is published by the seven UK Research Councils together, and an overview of the current and future infrastructure projects which in the RCUKs' opinion are the most relevant for the UK Research and therefore are advised for funding.
The roadmap considers actually rather large scale infrastructures, for which the funding cannot be provided by a single Research Council. More specifically, the projects included in the roadmap are those that

- are large and very extensive
- have long lifetimes (10-20 yrs)
- have multiple users both nationally and internationally
- are interdisciplinary
- offer unique capabilities within the UK, or more widely
- are potentially jointly funded or suitable subjects for international collaboration

The roadmap process

A first selection of the facilities to be included in the roadmap is done by the individual Research Councils, which then agree collectively on a short list of facilities eligible for the Large Facilities Capital Fund (LFCF). The Research Councils proceed then to a prioritisation exercise by using an agreed set of criteria, and the prioritized list is then agreed by the RCUK Executive Group.
Following this final prioritization, ministers then consider which projects should receive "earmarked" funds.

1. Life sciences vs. other research fields

The RCUK Roadmap 2008 [1] lists 67 facilities which are, in the Research Councils' opinion, of the highest strategic importance. The facilities are grouped in seven disciplines as given in Figure 1; the figure shows the number of facilities per disciplines and the corresponding percentages.
As usual, besides the 15 facilities categorized under "Biomedical and Life Sciences" there are a number of facilities under "Materials Sciences" which are extensively used also for life sciences applications. In the case of the RCUK roadmap, we can identify 8 such "LS-related" facilities, which are shown in Table 1.

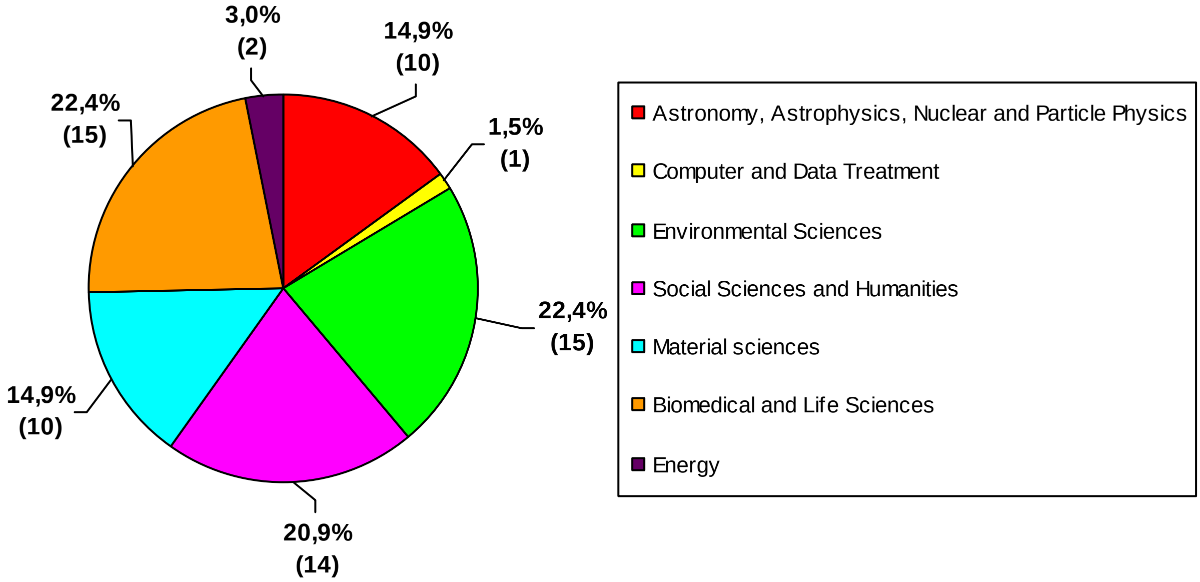

Figure 1 – Percentages (with in brackets absolute numbers) of recommended facilities for each discipline as given in the RCUK Large Facilities Roadmap 2008.

2. Current and foreseen status of RI in Life Sciences

Not addressed directly in the roadmap.

3. Gaps in RI and in RI funding

Possible gaps in RI and RI funding are not addressed in the roadmap.
Funding for large facilities in the UK is provided by the Large Facilities Capital Fund (LFCF), which is administered by DIUS (Department for Innovation, Universities and Skills). It amounts to £100 million per year and is intended for Research Councils investments in large facilities with capital funding that could not be accommodated from within Research Council budgets.

In order to qualify for the LFCF, facilities must be included in the roadmap and satisfy one or more of the following criteria:

- Have capital costs over £25 million;
- Have capital costs representing more than 10% of an individual Research Council's annual budget
- Serve the research communities of more than one Research Council.

Inclusion in the roadmap does not imply financing through the LFCF. Indeed, the facilities eligible for LFCF are prioritized by the Research Councils based on a number of predefined criteria. The Research Councils recommend then a number of facilities to be funded by LCFC to the ministers, who decide which projects should receive "earmarked" funding.

4. National vs. international orientation

The importance of participating in international facilities is stressed, and planning on when and how to participate should be guided on one side by the potential role for UK on the international scene, and on the other side by enhancing the international collaborations for UK researchers.

A substantial fraction of ESFRI projects are included in the roadmap, either because they might be constructed within the UK, or because access for UK researchers is desirable and therefore UK participation may be appropriate. It is stressed however that in many cases the decision on the UK participation is dependent on the outcomes of the preparatory phase studies.
For life sciences and Materials Sciences the selected ESFRI facilities are given in Table 1.

Biomedical and life sciences	BBMRI
	EATRIS
	EUSYSBIO
	ELIXIR
	Infrafrontier
	ECRIN
	INSTRUCT
Materials Science	ESRF
	X-FEL
	ELI
	ILL

Table 1 – ESFRI life sciences or LS-related Facilities included in the RCUK Large Facilities Roadmap 2008

A list of the facilities included in the RCUK roadmap and which either are categorized as life sciences or are categorized as Materials Sciences but have a significant range of applications in the life sciences is given in Table 2. For each facility the international or national character of the facility is given in the second column, while the third column indicates whether it is about a new facility, an existing one or an upgrade. The fourth column indicates whether the facility is single-sited or distributed – either physically or as a virtual infrastructure (e.g. databanks).

		National / international	Current / upgrade / new	Single-sited / distributed	Remarks
Biomedical and Life sciences	**BBMRI**	international	new	distributed	The FP7 preparatory study is being led by UK.
	EATRIS	international	new	distributed	Imperial College, London, is the proposed location for the cardiovascular diseases EATRIS centre.
	EUSYSBIO	international	new	distributed	Network that will be formed from the systems biology centres existing in nine EU countries, including UK.
	ELIXIR	international	new	distributed	The UK hub of the ELIXIR network will be based at the existing European Bioinformatics Institute (EBI) in Hinxton.
	Infrafrontier	international	new	distributed	Mary Lion Centre is a key participant in the proposal.
	ECRIN	international	new	distributed	
	Institute for animal health - Compton	national	upgrade	single-sited	
	Institute for animal health - Pirbright	national	upgrade	single-sited	
	INSTRUCT	international	new	distributed	preparatory phase is being led by UK
	Mary Lyon Centre	national	current	single-sited	National centre for the development of mouse models of human disease – Together with the Mammalian Genetics Unit (MGU) is included in several international projects and are partners in Infrafrontier.
	Laboratory for Molecular Biology	national	upgrade	single-sited	
	National Academic Drug Development Facility	national	new	not defined yet	
	Rutherford Appleton Laboratory (RAL)	national	current	single-sited	Support laboratory facilities for ISIS and Diamond.
	UK Biobank	national	current	distributed	
	National Institute for Medical Research	national	upgrade	single-sited	
Materials Science with LS applications	**Daresbury and Harwell Science and Innovation Campuses**	national/internationally oriented	new	distributed	Multidisciplinary structures located near big facilities and aimed at encouraging the exchange between Research Councils, Universities and high level industrial sector. Life sciences is one of the strategic themes.
	Diamond Light Source –Phase III	national/international	upgrade	single-sited	
	ESRF	international	upgrade	single-sited	
	X-FEL	international	new	single-sited	£ 31.5 million is currently earmarked from the LFCF for the full project.
	ELI	international	new	single-sited	
	ILL	international	current	single-sited	UK is one of the four major associates
	ISIS target station	international	upgrade	single-sited	
	New Light Source	national	new	single-sited	UK based free-electron laser

Table 1 – List of life sciences and LS-related facilities included in the UK roadmap

5. Types of RI

As can be seen from Table 2, about half of the facilities recommended for financing is new (twelve out of 23), for the ten existing facilities financing is intended for either upgrade (six cases) or for current expenses, for example for the final stages of development or to pay the participation quota to international facilities.
With respect to the type of research infrastructure, there is a slight majority of single-sited projects (14 out of 23) with respect to distributed projects.

Recent developments

On the same day the RCUK roadmap was published (14 July 2008), the UK National Department for Innovation, Universities and Skills (DIUS) announced a £397 million investment program for large-scale facilities through the LFCF [2]. The approved Life-Science related projects are:

- £67 million for the re-development of a new Laboratory of Molecular Biology
- £30 million for a new detector systems centre to be based at Harwell and Daresbury to research, design and produce sensors.
- £25 million for ISIS
- £92.5 million for Diamond Light Source – Phase III

Additional strategy documents at national level

Biotechnology and Biological Sciences Research Council (BBSRC)
The Biotechnology and Biological Sciences Research Council (BBSRC) has published recently an "International Strategy" [3] and a Delivery Plan for the period 2008-2011 [4].

In the period 2008-2009 to 2010-2011, BBSRC's budget will rise from £386 million to £471 million.
At the national level, with these funds BBSRC will continue supporting its institutes, the Systems Biology Centres and a Bioenergy Centre. Additionally, the following main priorities are mentioned:

- develop- with EBI RCUK and WELLCOME Trust- proposals for ELIXIR, which will be based at EBI in Cambridge;
- continue with the renewal of the Institute for Animal Health in Pirbright

At the international level, the BBSRC strategy focuses on:

- continuing to ensure access to top facilities to UK life scientists, in cooperation with STFC
- encouraging the UK research community to play a leading role in formulating international protocols for data sharing, storage and analysis
- participating in the ESFRI roadmap projects through FP7, in particular ELIXIR and INSTRUCT
- lobbying for continued investment in, and expansion of EBI
- participating in the ESFRI roadmap future revision and update processes

Medical Research Council (MRC)
The Medical Research Council has no specific infrastructure policy, and as a consequence, there seems to be no documentation on this subject [7].

The Wellcome Trust
The Wellcome Trust has an own strategic plan [5], the latest edition of which spans the period 2005-2010. An update of the plan was issued in 2008 [6]. With reference to research infrastructure, the plan focuses, among other, on a number of projects which have completed in 2006/2007 namely:

- the construction of a new building to house the EBI on the Wellcome Trust Genome Campus at Hinxton
- the completion of phase I construction of the Diamond synchrotron, in cooperation with the Research Councils

Plans for the future comprehend:

- Develop existing major resource partnerships – including UK Biobank, the Diamond synchrotron and Structural Genomics Consortium
- Continue to support the Wellcome Trust UK centres and Major Overseas Programmes

- Investments in e-Health – in cooperation with a.o the Department of Health – and in the use of electronic patient records and databases in research, this latter through joint initiative with the research councils.

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[5] Wellcome Trust, *Wellcome Trust Strategic Plan 2005-2010 - Making a Difference*, http://www.wellcome.ac.uk/About-us/Strategy/index.htm

[6] Wellcome Trust, *Wellcome Trust Strategic Plan Updates 2008*, http://www.wellcome.ac.uk/About-us/Strategy/index.htm

[7] Medical Research Council, personal communication.

List of acronyms

ARC	Australian Research Council
BBMRI	Biobanking and Biomolecular Resources Research Infrastructure
BBSRC	Biotechnology and Biological Sciences Research Council (United Kingdom)
BILS	Bioinformatics infrastructure for Biosciences (Sweden)
BIMS	Swedish National Biobank Information Management System (Sweden)
DoE	Department of Energy (United States)
DIUS	Department for Innovation, Universities and Skills (United Kingdom)
EATRIS	European Advanced Translational Research Infrastructure in Medicine
EBI	European Bioinformatics Institute
ECRIN	Infrastructures for Clinical Trials and Bio-therapy
ELI	Extreme Light Infrastructure
ELIXIR	European Life-Science Infrastructure for Biological Information
EMBL	European Molecular Biology Laboratory
EMBC	European Molecular Biology Conference
ESRF	European Synchrotron Radiation Facility
ESS	European Spallation Source
EMBRC	European Marine Biological Resource Centre
EUSYSBIO	European Centre for Systems Biology
FECYT	Fundación Española para la Ciencia y la Tecnología
FORFÁS	National policy and advisory board for enterprise, trade, science, technology and innovation (Ireland)
IBISA	Biology, Health and Agronomy Infrastructure (France)
Infrafrontier	European Infrastructure for Phenotyping and Archiving of Model Mammalian Genomes
GSRT	General Secretariat for Research and Technology (Greece)
HEA	Higher Education Authority (Ireland)
IARC	International Agency for Research on Cancer, WHO
ILL	Institut Laue-Langevin
INCF	International Neuroinformatics Coordinating Facility
INSTRUCT	Integrated Structural Biology Infrastructure
LFCF	Large Facilities Capital Fund – (United Kingdom)
LIEF	Linkage Infrastructure and Equipment Fund (Australia)
MIMS	Laboratory for Molecular Infection Medicine Sweden (Sweden)
NCRIS	National Collaborative Research Infrastructure Strategy (Australia)
NCRR	National Center for Research Resources (United States)
NHMRC	National Health and Medical Research Council (Australia)
NIH	National Institute of Health (United States)
NSF	National Science Foundation (United States)
NWO	Netherlands Organization for Scientific Research
RCUK	Research Councils UK
SweIMP	Swedish Mouse Phenotyping facility
X-FEL	European X-ray Free-Electron Laser