The Netherlands’ Roadmap for Large-Scale Research Facilities

National Roadmap Committee for Large-Scale Research Facilities

BALANCING ACT

Perhaps we stayed under water too long
-- remember the effort it took
to make it onto dry land and stay there:
gnawing away gills, giving hands and feet
to fins, converting scales to fur,
adopting a different air, doggedly trying
to make the tail between the legs
disappear -- to even think of wanting to fly.

A sufficient amount of gravity
complemented by an inconceivable lack
of wings keeps us grounded
except when we submerge
want to lie down to sleep for example
or have climbed high into a tree
for a better view of the sea because we are
expecting ships that may sail by.

Wiljan van den Akker
(Translation by Roselinde Supheert)

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Contents

Summary

Large-scale research facilities are of inestimable strategic value for science and research and, hence, for the Dutch knowledge economy. In July 2007, the Dutch Minister of Education, Culture and Science set up the National Roadmap Committee for Large-Scale Research Facilities, whose main task was to advise him as to which large-scale research facilities the Netherlands should construct or participate in within an international context.

In the present advisory report, the Committee presents 25 large-scale research facilities whose construction or operation the Committee believes is important for the robustness and innovativeness of the Dutch science system.

Humanities and Social Sciences
CLARIN (Common LAnguage Resources and technology INitiatieve) (level A)*
ESS (European Social Survey) (level B)*
SHARE (Survey of Health, Ageing and Retirement in Europe)**
DARIAH (Digital Research infrastructure for the Arts and Humanities)*
DISS (Data Infrastructure for the Social Sciences)

Natural Sciences and Technology
European XFEL (X-ray Free Electron Laser) (level B/C)*
KM3NET (Cubic Kilometre Neutrino Telescope) (level B)*
E-ELT (European Extremely Large Telescope) (level B)*
ESS (European Spallation Source)**
PRINS (Paneuropean Research Infrastructure for Nano-Structures)**
SKA (Square Kilometre Array)**
HFML (High Field Magnet Laboratory)*
Nanolab

Environmental Sciences and Energy
ICOS (Integrated Carbon Observation System) (level B)*
LIFE WATCH (Research Infrastructures Network for Research in Biodiversity) (level B)*
EWAC (European Water Assessment Centre)
NCB (Netherlands Centre for Biodiversity)
Solar Energy
TFLAB (Dynamic Two Phase Flow Laboratory)

Life Sciences and Medical Sciences

European Biobanking and Biomolecular Resources (level A)*
EATRIS (European Advanced Translation Research Infrastructure for medicine)**
EURO-BioImaging*
MCCA (Mouse Clinic for Cancer and Aging Research)
NeCEN (Netherlands Centre for Electron Nanoscopy)

E-Science

Towards a National Research Infrastructure

The Committee also makes the following recommendations.

1. Stick to the priorities set out in the Roadmap

The Netherlands' Roadmap for Large-Scale Research Facilities lists 25 large-scale research facilities. Immediate political and financial support is being requested for eight facilities that are also listed in the 2006/2008 European Roadmap. The Committee advises the Minister to order NWO to use the sum allocated to it for large-scale research facilities (EUR 63 million for the 2008-2012 period) specifically to finance these eight ESFRI facilities.

2. Develop the necessary ancillary policy when implementing the Roadmap

Large-scale research facilities involve more than money alone. The Committee advises the Minister to develop ancillary policy in the following areas:

- developing outstanding talent;
- encouraging collaboration;
- clustering;
- developing attractive employment terms;
- developing the ICT infrastructure;
- taking steps to introduce a legal framework for a European research infrastructure as quickly as possible.

3. Elaborate alternative financing arrangements

The research infrastructure has been funded primarily by means of incentive grants to date (some of these grants have been long-term and generous). Incentive grants have advantages from the researcher's viewpoint, but there are also disadvantages.

The Committee advises the Minister to have three alternative funding mechanisms elaborated.

*: also included in the European Roadmap 2006/2008

**: also included in the European Roadmap 2006/2008 (political support)

Red: the 'eight', listed in order of priority per domain (financial and political support)

4. Subject the financing of large-scale research facilities to critical analysis
Large-scale research facilities entail major investments. The Committee therefore advises the Minister to apply the key criteria ‘willingness to collaborate’ and ‘open accesses as key criteria when selecting large-scale research facilities. The Committee also advises the Minister to reserve part of the 2009/2010 FES round for large-scale research facilities, and to order the Rathenau Institute to assess the current and future expenditure on the Dutch research infrastructure or any foreign research infrastructure to which the Netherlands makes a major contribution. Finally, the Committee recommends that the Minister appoint a working group to assess the alternative forms of financing described in this report.

5. Set up a fund to finance large-scale research facilities before the end of the present Government’s term in office
The significance of large-scale research facilities for the Dutch knowledge-driven economy is clear. The Committee advises the Minister to set up a fund to finance large-scale research facilities before the end of the present Government’s term in office.

Foreword

The Netherlands' National Roadmap Committee for Large-Scale Research Facilities (hereafter referred to as the 'Committee') was inaugurated on 9 July 2007 at the request of the Dutch Minister of Education, Science and Culture. Appendix 1 lists the Committee's members.

Article 2 of the Resolution inaugurating the Committee (see Appendix 2) describes its establishment and task:

1. There is a National Roadmap Committee for Large-Scale Research Facilities.
2 The task of the Committee is to draw up a national roadmap pre-selecting and prioritising potential large-scale research facility projects in the Netherlands for purposes of scientific research. The Committee will take the following matters into account:
   a. coordination with developments in Europe, in particular the development of the ESFRI roadmap; and
   b. the criteria set out in the Nijkamp Report and applied in implementing the NWO-BIG grant programme for large-scale research facilities and the ESFRI roadmap.

The budget for Education, Culture and Science published on Budget Day 2007 made clear that the Government would also appreciate the Roadmap Committee's advice on enhancing synergies; the Committee has interpreted this primarily as a request by the Minister to advise on how best to coordinate the various government funding mechanisms for the Netherlands' knowledge infrastructure.

In publishing the Roadmap, which encompasses 25 large-scale research facilities, the Committee wishes to offer the Minister of Education, Culture and Science strategic advice as to which large-scale research facilities the Netherlands should construct or Dutch researchers should participate in within an international context.

The Committee has had the privilege of acquainting itself with a cross-section of the Dutch research community in the past 18 months. Its opinion of the excellent quality and social relevance of Dutch research has been confirmed. The Committee has become increasingly convinced of the importance of establishing a structural fund for large-scale research facilities. It believes that the current practice – in which there are a host of different funding mechanisms, each with its own separate procedure – is undesirable. The Committee therefore advocates establishing a structural investment fund for large-scale research facilities before the end of the present Government's term in office.

This document constitutes the Netherlands' first Roadmap. The Roadmap is an advisory report intended for the Minister of Education, Culture and Science; it is not a roadmap in which central government communicates information about pending projects and how they are financed. The Committee believes that the Roadmap should be updated in two years' time, for two reasons. First of all, a Roadmap is not a static document; it should describe new opportunities and trends. Secondly, in two years it will be necessary to assess whether the large-scale research facilities covered in the Roadmap are on target or whether any of the facilities should be taken off the list and replaced by another facility. The Committee therefore advises organisations that have submitted unsuccessful proposals to continue working on their initiatives. A proposal that was unsuccessful now might very well be included in the Roadmap in two years' time.

The fact that the Committee has been able to dedicate itself to its task is largely thanks to the assistance it has received from so many different parties in the past eighteen months. On behalf of the Committee, I would like to thank everyone for their cooperation. The involvement of so many has convinced the Committee that it has a good basis of support for the choices made in the Roadmap.

On behalf of the Roadmap Committee,

W.G. Van Velzen
Chairperson

1. The significance of large-scale research facilities

In a speech delivered to the Swedish Parliament on 4 March 2008, the EU Commissioner for Science and Research, Mr Janez Potočnik, said that there is competition worldwide between people, companies and places. People and companies are increasingly mobile, but places are not, he argued. Potočnik also pointed out that what drives corporate R&D investment is the reasonable prospect of a return on investment. If a company believes it has access to a large European market, it will invest. But the size of the market is not everything. Companies must also be able to tap into the talent, the science and the pioneering knowledge developed by universities and research centres. 'No company can afford any more to run a closed R&D shop.'

In the Netherlands, the Scientific Council for Government Policy (WRR) recently published a report *Innovatie Vernieuwd*[1] describing how government can map out a sustainable economic growth strategy that will stimulate continuous innovation in our economic structure. The WRR concludes that government must take the lead in fostering innovation in public sectors and in tackling major social issues that are not market-led. Government must also accept that it may make wrong choices on the way to achieving valuable innovations.

Both Mr Potočnik and the WRR have emphasised the importance of creating an outstanding knowledge infrastructure that stimulates scientific research. A report by the Netherlands Observatory of Science and Technology (NOWT) on science and technology indicators in 2008 *Wetenschaps- en Technologie-Indicatoren 2008* has revealed that the Netherlands is among the world's highest-ranking countries in terms of scientific impact: its citation impact score in most fields is above the world average, and in a number of cases well above average.[2]

Dutch research, and with it the government's sustainable economic growth strategy, therefore occupy a good starting position. The NOWT reports, however, that the Netherlands' 'science fingerprint' shows a lack of relatively large-scale fields in which it is also strong, and that the various scientific fields differ noticeably in terms of their international prominence.

The present Government attaches great importance to creating an excellent knowledge infrastructure. It has made that clear by increasing government investment in research. In its recently published long-term strategy *Naar een agenda voor duurzame productiviteitsgroei*, the Government reports a major increase in investment in education, research and innovation, rising to an annual EUR 2.5 billion in 2011, based in part on the Innovation Platform's Knowledge Investment Agenda (KIA).[3] The Committee is gratified by this development. At the same time, it is clear that the Netherlands must make a major effort to implement the KIA in its entirety. Further action must therefore be taken.

The importance that the Government attaches to boosting the Dutch knowledge infrastructure is necessary not only because of the intrinsic value of scientific progress, but also in view of the challenges facing the Netherlands in the decades ahead, for example climate change, the ageing population, the exhaustion of natural resources and the loss of biodiversity. If the Netherlands aims to tackle these challenges head-on, it must retain its present leading position in research.

One significant requirement for an outstanding knowledge infrastructure is the presence of large-scale research facilities. In its 2005 Nijkamp Report *Kennisambitie & researchinfrastructuur*, the Innovation Platform argued convincingly that it was of major scientific, economic and social importance for the Netherlands to have or participate in large-scale research facilities.[4]

The Committee agrees with the Innovation Platform: large-scale research facilities are of inestimable strategic significance for the Dutch knowledge economy and for a flourishing innovation climate. More specifically, the following four factors are important:

Large-scale research facilities provide vital tools for scientific progress and for conducting outstanding research

Scientific progress depends on a combination of talented, creative researchers and the availability of good research facilities. Researchers increasingly require an ever-larger research infrastructure. This trend parallels a shift from a soloist research tradition to a culture in which multidisciplinary cooperation is standard. The future of scientific progress and the ability to conduct excellent research depend increasingly on the concerted action of research teams with outstanding large-scale research facilities.

Large-scale research facilities are of huge social and economic relevance

All large-scale research facilities have an advanced technical component in which state-of-the-art technology is deployed. Research conducted using large-scale facilities also often produces useful industrial and socially relevant applications. Direct and indirect expenditure on investment and the operation of such facilities benefits the local and regional economy (one example is ESTEC, with a multiplier effect of 3 to 5). If they operate according to the open innovation model, large-scale research facilities can also have a positive impact on the facilities of small and medium-sized enterprises and start-up companies.

Large-scale research facilities lead to concentrations of human capital

State-of-the-art facilities act as a magnet for top researchers and students. Locations that have the best research infrastructure and the most inspiring working environments enjoy 'brain gain'. International examples of such environments are Geneva (CERN) and Heidelberg (EMBL).

Large-scale research facilities act as a hub

Large-scale research facilities involve a combination of state-of-the-art, innovative technology and highly skilled personnel working in an inspiring learning environment. Large-scale research facilities are not only about technology; they are about the dynamic interaction between technology, people and capital.

When asked how a large-scale research facility should be defined, the Committee, following in the footsteps of the Innovation Platform, came up with the following two categories, both related to a facility or 'tool for science', and not to a research programme:

In the first category, the hardware predominates. There is a single large device in a building or a number of interconnected devices in a highly specialised building (for example a clean room), with associated expenses for supplies and personnel. Sometimes the research focuses on a well-defined area: the best known examples are particle physics (CERN), astronomy (ESO) and space exploration (ESA). A growing number of facilities are multifunctional, however. The large-scale facilities may welcome thousands of researchers a year working in a huge number of disciplines.

The second category more closely resembles an organised cluster of national, localised hardware and expertise around an international hub, leading to the development of a new distributed facility. Examples are the Global Biodiversity Information Facility and the initiatives associated with DARIAH.

Examples of large-scale research facilities include:

- research collections;
- databases;
- broadband connections, high-performance supercomputers and grids;
- clean rooms with state-of-the-art equipment and furnishings;
- laboratories and/or animal-testing facilities for biomedical research;
- telescopes and accelerators;
- synchrotron radiation facilities and neutron sources, free-electron lasers, molecular imaging techniques, high-magnetic fields, and other facilities required to study living and dead matter;
- tanks;
- advanced vessels for maritime research.[5]

Large-scale research facilities involve major investments (a minimum of EUR 40 million over a ten-year period). In a background study commissioned by the Committee, the Rathenau Institute describes large-scale research facilities as science's knowledge-intensive capital.[6] The scientific, social and economic importance of investing in large-scale research facilities is therefore patently clear. Recognition of this importance is why the Minister also asked the Committee to advise him on how to generate more synergy between the various funding mechanisms applied by government to reinforce the Dutch research infrastructure.

It is crystal-clear to the Committee that private funding, European research funding, university matching obligations and other funding arrangements must be more closely coordinated. It therefore organised two meetings to discuss this topic at length with many of those directly involved. It also asked the Rathenau Institute to investigate the issue of synergy in greater detail.[7] The investigation – which the Rathenau Institute will publish as a separate background study – revealed that synergy can take on many different forms in actual practice. The study shows that the more the following questions are answered in the affirmative, the greater the likelihood of positive synergies:

1. Does the large-scale research facility foster continuous improvement in scientific instruments?
2. Is the large-scale research facility generating concentrations of social networks and human capital?
3. Is the large-scale research facility a source of technological innovation?
4. Does the large-scale research facility join together a wide range of different parties and their interests?
5. Does the large-scale research facility have the status of a leading international facility?

Although large-scale research facilities require major investments, the Committee has decided against including a financial section in this report. It did not allow itself to be led by financial considerations when drawing up the Roadmap. The Committee's primary concern was to produce a roadmap that enables the Minister to set priorities for science. Only then will the search for the necessary funding begin. This approach implies that the Committee has not examined the financial underpinnings of the facilities included in the Roadmap. This will naturally have to be examined at a later stage.

It is clear is that the importance of large-scale research facilities is increasingly being recognised worldwide as a necessary criterion for strategic research and innovation policy. During the Dutch presidency of the European Union in 2004, the former Minister of Education, Culture and Science, Maria van der Hoeven, told EU ministers at the informal meeting of the Competitiveness Council (Maastricht, July 2004) that the expense and complexity of building the next generation of large-scale research facilities would require European cooperation. Her arguments found broad support. There was recognition on all sides that Europe's policy on joint research programmes was still fragmented. At the same time, it was also recognised that creativity should not be sacrificed to coordination and that competition should not become the victim of bureaucratic planning. The EU faced the challenge of finding the right mechanisms to create more joint programmes while preserving creativity and competition, and it was partly at the proposal of the Netherlands that the European Strategy Forum on Research Infrastructures (ESFRI) was asked to take up this challenge by drafting the first European Roadmap.

The first European Roadmap was published October 2006 and covered 35 large-scale research facilities divided into three domains:[8]

a. Social Sciences & Humanities;
b. Physical Sciences & Engineering;
c. Biological & Medical Sciences.

Thanks to ESFRI, which will publish an update of the 2006 European Roadmap in December 2008, the topic 'large-scale research infrastructure' has been given greater priority on the European political agenda. A number of countries (Denmark, Finland, France, Germany, Greece, Malta, Romania, Spain, Sweden and the UK) have also developed their own national Roadmap, and Denmark, Germany, Spain and Sweden have made extra monies available to set up a fund for a large-scale research infrastructure. The G8's R&D Ministers also agreed in June 2008 to develop the first joint G8 Roadmap.

In order to keep pace with developments in Europe and set national priorities, the Netherlands must have its own national roadmap. It is important to realise, however, that the ESFRI does not concern itself with the funding of facilities. Such decisions are taken by alternating groups of member states, based on previously developed national roadmaps setting out national priorities. This applies equally for the facilities included in the Netherlands' Roadmap.

2. Procedure

The Netherlands' National Roadmap is a combination of large-scale research facilities that are found in the European Roadmap 2006/2008 and facilities nominated by Dutch research organisations.

With respect to the facilities listed in the 2006/2008 European Roadmap, the Committee based its selection on the 35 facilities included in the 2006 European Roadmap. The Committee also invited Dutch research organisations to submit proposals for the Roadmap (see Appendix 3 for the letter of invitation and the list of recipients). These organisations made extensive use of this opportunity, with the Committee receiving a total of 56 proposals. The Committee therefore assessed a total of 91 large-scale research facilities. Committee members directly involved with a facility did not take part in the deliberations or voting.

Each of the 91 facilities was assessed on the basis of 11 criteria, with the first six being included in the Resolution inaugurating the Committee and also applied by ESFRI:

1. The likelihood of scientific breakthroughs (science case)
Innovation is dependent on scientific breakthroughs. If one wants to make major investments in research facilities, they must lead to a greater likelihood of scientific breakthroughs in the research field concerned, or at least aid in that process.

2. The potential for 'brain gain' (talent case)
A knowledge-driven economy cannot do without highly promising researchers. To bring such people to the Netherlands – or to keep them here – one needs to provide them with an attractive and challenging working environment. Advanced research facilities are essential here.

3. Social and commercial relevance (innovation case)
Research facilities are necessary for business and industry and for innovative public bodies. Large-scale research facilities act as a magnet for new knowledge and expertise, thus creating an excellent climate for companies both large and small.

4. Collaboration and competition (partnership case)
Large research facilities are embedded in wide-ranging networks. Research at large facilities takes place via networks (which may be international). Facilities with a large 'critical mass' also ensure synergy between knowledge workers.

5. Financial aspects (business case)

Innovation costs money. The cost of bringing a facility of international renown to the Netherlands and operating it here will exceed the available budgets. Careful budget analysis is therefore necessary.

6. Technical feasibility/technical challenges (technical case)

New facilities involve risks, and it is therefore important to know whether it is in fact technically possible to construct the facility concerned. It is a good idea to also estimate the technical challenges because these may also be another reason not to embark on setting up the facility.

7. Possible focus for the Netherlands

When assessing each facility, the Committee posed the following questions:

a. Is the Netherlands an international leader in the field concerned?
b. Can the Netherlands achieve a unique position (in a sub-area)?
c. If it is foreign research groups that are the international leaders, are there nevertheless reasons to invest in this facility and thus to enter into scientific competition?

8. Critical mass

Large-scale research facilities are mainly intended for researchers. In the view of the Committee, this means that there should be investment in research facilities in those fields of research in which there are already enough top researchers in the Netherlands, both as regards quality and numbers. The results of recent external reviews of research should also show that Dutch research groups are international leaders in their field.

9. Embedding

Large-scale international research facilities need to be financially and institutionally embedded within the Dutch knowledge infrastructure. In the view of the Committee, this also applies to the large-scale international research facilities where the Netherlands does not play the leading role. Such institutional and financial embedding can be demonstrated by such things as the concentration of research groups in the Netherlands, the embedding of Dutch research groups within European networks, and the investment made by the Dutch government, for example through the Economic Structure Enhancement Fund (FES), in the relevant research fields.

10. Proven willingness to collaborate

The Committee attaches great importance to collaboration and the wish to collaborate. The large-scale research facilities must reinforce collaboration between the Dutch research groups concerned in the particular research field. Those research groups should have confirmed their intention to collaborate from the financial point of view by devoting a certain percentage of their research budget to the large-scale research facility concerned.

11. Reflection of social trends

The Committee attaches great importance to the social relevance of research. It therefore considers it important to devote attention not only to scientific and economic aspects but also to national social changes and trends, as shown, for example, by the social innovation agendas drawn up by the Government in the areas of water, energy, healthcare, and security.

In assessing the 91 facilities, the Committee has distinguished between those that were included in the European Roadmap 2006 and those proposed by the Dutch research organisations.

Procedure for assessing ESFRI facilities

The 35 facilities on the European Roadmap 2006 were subjected to stringent international assessment before being included. The Committee did not undertake to repeat that international assessment, but it did test the 35 ESFRI facilities against the 11 assessment criteria referred to. The Committee also asked which ESFRI facilities required immediate support from the Dutch perspective. In determining the answer to that question, the Committee considered various aspects, including the following:

1. Has a group of leading Dutch researchers explicitly stated that they are using/ will use the facility concerned?
2. Have significant manpower and funds already been invested in the facility concerned – in expectation that a 'go' decision can be achieved through international joint efforts – or has there been investment at national level, for example in the form of FES funds, leading to good opportunities for participating in an ESFRI facility?
3. How are the international ESFRI negotiations progressing, where are there opportunities for the Netherlands, and what ESFRI facilities should the Netherlands invest in in this connection in the very near future?

The Committee then distinguished between three levels of participation in respect of each ESFRI facility:

Level A: bringing the large-scale facility to the Netherlands; construction and operation;
Level B: collaborating on developing the large-scale facility; enabling technology;
Level C: using the large-scale facility; utilisation.

Procedure for assessing research facilities proposed by Dutch research organisations

In the case of the 56 proposals by Dutch research organisations, the Committee received a summary of each proposal based on the 11 assessment criteria. When assessing and prioritising the summaries, the Committee made use of the advice given by NWO in collaboration with SenterNovem. The Committee itself first assigned an initial assessment to each summary on the basis of the 11 criteria. It then sent all the summaries, with its own assessments attached, to NWO and SenterNovem. NWO and SenterNovem assessed the summaries and submitted their joint advice on each of them to the Committee. The Committee then compared the advice provided by NWO and SenterNovem with its own initial assessment. It did not express a new opinion regarding the 35 facilities included in the European Roadmap. It also looked at a balanced portfolio. On the basis of all these considerations, the Committee ultimately selected 16 summaries for further elaboration in line with a format drawn up by NWO/SenterNovem. Thirteen of the 16 elaborated proposals were sent to NWO/SenterNovem for international peer review. The Committee considered two elaborated proposals to be insufficient. In the case of one proposal ('Pallas', submitted by NRG), there was discussion with NWO as to how assessment should best be effectuated. The Pallas project is made up of four components:

1. research for reducing nuclear waste;
2. research on materials for the fourth generation of nuclear reactors;
3. research on materials for a fusion reactor;
4. production of radioactive isotopes (healthcare).

A separate procedure was implemented in order to assess the Pallas project; this has not yet been completed. Once the Committee has received comments from the international reviewers, as well as the response of NRG, it will submit separate recommendations on this project to the Minister.

The international peer review of the 13 proposals confirmed the Committee's view that virtually all the proposals selected relate to Dutch research facilities that enjoy international status and an international reputation. The Committee excluded one proposal from the Roadmap; this was due to the critical international assessment of that project.

3. Roadmap

Based on the procedure described in section 2, the Committee selected 25 facilities that together constitute the Netherlands' Roadmap. Section 7 describes each facility separately.

The Roadmap is made up of three different segments

- The first segment consists of eight ESFRI facilities that require the Dutch government's immediate financial and political support, in the Committee's opinion. As explained in section 2, the Committee has distinguished between three different levels of participation in respect of these eight facilities. The Committee is gratified that the Minister has ordered NWO to use the sum allocated to it for large-scale research facilities (EUR 63 million for the 2008-2012 period) specifically to finance these eight ESFRI facilities.
  The second segment consists of five ESFRI facilities (SHARE, ESS, PRINS, SKA and EATRIS) that the Committee believes currently require more political than financial support in order to ensure a sound starting position in the European negotiations.
- The third segment consists of three ESFRI facilities (DARIAH, HFML and Euro-BioImaging) and nine facilities nominated by Dutch research organisations. A number of these facilities applied for funding under – and may in fact be financed from – the FES. With respect to facilities that will not be funded during the current FES round, the Committee recommends their being nominated for the next round or for funding to be set aside in the 2009/2010 interim budget or the 2010/2011 budget.
- The Committee would draw specific attention to three facilities in the Netherlands' Roadmap. These are the European Water Assessment Centre (EWAC), the Netherlands Centre for Biodiversity (NCB) and the national ICT research infrastructure. The Committee would wish the Roadmap to include facilities focusing on these themes (water, biodiversity and ICT respectively). The international reviewers have stated, however, that the three relevant proposals will require further elaboration at a later stage.

The Netherlands' Roadmap

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Red: the 'eight', listed in order of priority per domain (financial and political support)

4. A new financial framework

General remarks

Large-scale research facilities are capital goods. The Committee is therefore advising on an investment (cost of capital). Decisions concerning investments have repercussions for various parties, some of them in the long term. Investments in research facilities also create obligations elsewhere in the research structure. For example, there must be enough research funding available to make effective use of the facility, and policy must be developed to ensure that researchers in industry and abroad have access. Investments in large-scale research facilities also create financial obligations related to their maintenance, renovation and disassembly. Facilities have a long life cycle, from five to ten years for electronic scientific equipment and up to thirty years for large-scale hardware (such as research vessels or radio telescopes).[9] Finally, investments in large-scale research facilities also have long-term financial implications for the other participants, as they are accompanied by expectations vis-à-vis co-financing, whether or not in the form of a matching obligation.

A large-scale research facility has a long life cycle and is more than just a 'tool for science'. It is itself the object of research. Scientific and technical research is required to design the facility. A facility's sophisticated technology also generates more research and offers a platform for developing the next generation of facilities. That means ongoing synergy between the various research funding mechanisms on the one hand and the investments and cost of capital on the other. One of the key features of a large-scale research facility is that it is too big to be financed, managed or used by a single party. Developing and constructing a large-scale facility therefore necessarily means mobilising resources in cooperation with other parties, with each participant having its own objectives and interests. Having a clear prospect of financing within a reasonable period of time can encourage cooperation. For example, some of the synergies associated with a large-scale research facility are generated by joining with various parties to mobilise funding.

Structural fund for large-scale research facilities

In 2005, the Innovation Platform argued in favour of establishing a structural fund to finance large-scale research facilities. The fund would receive a minimum annual input of EUR 125 million. Until now, no fund has been established. However, the Committee can report two positive developments. The first is that as of 2008, structural funds will be added to the NWO's budget for large-scale research facilities. The amount itself is modest (too modest), but the message it sends is a hopeful one. Secondly, in its long-term strategy, the Government has announced its intention to channel a steady stream of funds to the FES and to promote continuity and innovation in the current incentive projects.

Government is making a substantial investment in large-scale research facilities via the measures described above. This will mainly take the form of incentive grants. Following in the footsteps of the Advisory Council for Science and Technology (AWT)[10], the Committee advocates establishing a structural fund to finance large-scale research facilities. A fund of this kind should be set up by the end of the present Government's term in office. It could also be used to cover the operating costs of a large-scale research facility for the first ten years of its existence.

In addition to establishing a structural fund, the Committee has identified four other ways to help increase the budget for large-scale research facilities.

Enhance public–private cooperation

Public-private cooperation is nothing new and is now customary practice. Government has invested many millions in FES research projects with infrastructure elements.[11] In order to ensure continuity and maintain the momentum of innovation, government should sit down with the project partners, including the relevant enterprises, to discuss the research agenda and identify what contribution trade and industry is willing to make. It is naturally important to avoid any semblance of state aid, either direct or indirect, but the Committee imagines that such an approach opens up new opportunities. The European Commission's Communication of December 2007 is important in this respect; it describes a procedure for the pre-commercial procurement of R&D. The Commission also refers in its Communication to the technological breakthroughs that have been achieved in this way, for example GPS, Internet Protocol, high-performance computing and advances in chip technology.[12] One potential task for the working group described by the Committee in section 6 would be to investigate how to boost public-private cooperation.

Make better use of relevant European funding

The current 7th European Framework Programme for Research and Development offers the Netherlands tremendous opportunities in the form of co-financing. The European Commission already finances the preparatory phase of the current ESFRI projects. In addition, there are also other possibilities. There are specific programmes, such as the Strategic Energy Technology Plan (SET). In view of the importance of the ICT infrastructure and its leading position in this field, the Netherlands should be closely involved in developing the third generation GEANT, in which the EU is investing EUR 90 million until 2012.

A relatively new European facility is the Joint Technology Initiative (JTI), whose purpose is to finance large-scale multinational research activities. A JTI brings public and private parties together to define common goals of major social relevance.[13] It is important to investigate which facilities are already being financed and how the Netherlands can make better use of them through the clever use of funds.

The European Research Council (ERC) is also important in this respect, with an annual budget of approximately EUR 1 billion. It is naturally the task of the researchers and their consortiums to actively seek out opportunities for matching and using the various sources of financing within the ERC.

Reinforce the synergy between the European programmes

The EU has three important financing tools at Community level:

a. the cohesion policy financed by the structural funds and the Cohesion Fund;
b. the Framework Programme for Research and Development (FP7);
c. the Competitiveness and Innovation Framework Programme (CIP).

The European Commission has taken steps to increase synergies between these three instruments since August 2007.[14] The pre-enlargement member states (EU-15) have agreed to earmark between 60% and 75% of the available funds allocated to cohesion policy programmes for Lisbon-related investment, specifically within the context of R&D. The various programmes all run from 2007 to 2013. According to the European Commission, these programmes will involve a sum of approximately EUR 45 billion. The EU wishes to generate more research infrastructure synergies in this way between its cohesion policy and FP7. It also wants to involve the twelve new EU member states in the ESFRI Roadmap in a meaningful way.

The significance of all this should not be underestimated. It offers those involved in large-scale research facilities an opportunity to investigate their eligibility for one or more funding facilities.[15] It means consulting provincial and regional governments, because they are usually the drivers of such projects. It makes it possible to consider whether a research facility should be built in one of the new member states, with the Netherlands still playing a significant role in the project. Finally, it makes clear that the Netherlands can make better use of EU funding than it now does.

Make better use of the new EIB-EU financial facility

The European Investment Bank (EIB) and the EU introduced a new financial facility in August 2008, known as the Risk Sharing Finance Facility (RSFF). The EIB and the European Commission have developed this facility to give private enterprises or public research institutes easier access to loans. The EU and the EIB have both set aside EUR 1 billion, making a total of EUR 2 billion available in loans or guarantees. Because every FP7 and EIB euro translates into five times an RSFF loan or guarantee, the RSFF will be able to finance up to EUR 10 billion. Applicants for loans or guarantees can approach the EIB directly or through the relevant financial institutions. The applicants must naturally meet a number of requirements. The most important is that they must be able to demonstrate sufficient cash flow to meet their financial obligations in the coming years. This facility is interesting mainly because it considerably lowers the high start-up costs, provided that operations generate sufficient financial results to meet the repayment obligations.

In the past it has proven difficult to combine financial resources from different funding sources. Now that large-scale research facilities have become a hot item on the political agenda, the importance of clever financing is growing. That is why section 6 recommends setting up a working group to produce suggestions on this topic, taking the above-mentioned aspects of the financial framework into account.

5. Ancillary policy

There is more to developing large-scale research facilities than constructing a building with devices or setting up a distributed facility. The multinational nature of such facilities and the international collaboration they entail also require ancillary policy at European and national level.

The WRR refers in its report *Innovatie vernieuwd* to research showing that the Netherlands ranks twentieth on the list of attractive locations for foreign R&D.[16] This score is not in line with the Netherlands' ambitions, certainly not when we consider the long-term strategy for sustainable productivity growth set out by the Government *Naar een agenda voor duurzame productiviteitsgroei*. That strategy has three aims:

1. to enhance and make use of talent;
2. to enhance and make use of the knowledge gained in publicly and privately funded research;
3. to promote innovative entrepreneurship.

Large-scale research facilities can clearly make an important contribution to achieving these aims. The Government's strategy also provides a frame of reference for getting the most out of the large-scale research infrastructure.

Ancillary policy: Collaboration

One overriding concern in the Government's strategy is to encourage collaboration. In assessing the facilities nominated for the Netherlands' Roadmap, the Committee therefore stressed this aspect. Two key success factors for large-scale research facilities are a willingness to collaborate and open access. They are equally important factors for promoting public-private partnership between universities/top institutes and private enterprise. In its study of innovation, the WRR also emphasised the importance of collaboration.[17] Collaboration furthermore leads to spin-off companies, and it is a well-known fact that new forms of business activity have developed in the orbit of CERN, IMEC and Grenoble, for example. Such centres become attractive locations for new businesses, with the accompanying spill-over effects. Collaboration is also leading to clustering around the top research institutes, and the 37 projects now under way under the BSIK (Decree regarding Subsidies for Investment in the Knowledge Infrastructure) are contributing to clustering as well. Clustering leads to a critical mass of researchers, talent and infrastructure, and in turn gives the regional economy an extra boost. Collaboration that leads to clustering also brings together research, education and innovation in a 'knowledge triumvirate' and generates employment.

The Association of Large Technological Institutes in the Netherlands has indicated to the Committee that collaboration between university and non-university research organisations and their mutual utilisation of large-scale research facilities can be improved. The Committee agrees with the Association that there is a need to investigate how better use can be made of large-scale research facilities in the Netherlands and how overlaps can be avoided in any new facilities. This investigation could be undertaken by the working group proposed by the Committee in section 6.

Ancillary policy: employment terms

The study carried out by the Rathenau Institute makes clear that synergy is more likely when a large-scale research facility develops into a concentration of social networks and human capital. Any ancillary policy should therefore be concerned with researcher employment terms in the various member states. Utilisation of large-scale research facilities is by definition a pan-European affair, and researcher mobility is therefore an issue that is not confined to the Dutch context.

In May 2008, the European Commission launched the plan *Better careers and more mobility: a European partnership for Researchers*. In this plan, the Commission explains how it intends to encourage talent in the EU and improve career opportunities by:

a. opening recruitment by research institutes in the EU to all European researchers;
b. meeting the social security and supplementary pension needs of mobile researchers;
c. providing attractive employment and working conditions, such as improved contractual terms, salaries and opportunities for career development;
d. creating stronger links between universities and industry.

For the Netherlands, the Commission's plan means that more attention must go to social security and pension shortfalls, and that the employment terms must be made more attractive. It is important that the Netherlands actually implement the decisions adopted at the most recent Social Affairs Council.

Ancillary policy: ICT

Thanks to the BSIK projects, the Netherlands has an excellent ICT infrastructure. It is crucial for the Dutch research infrastructure that continuity in this matter is guaranteed; after all, ICT is a necessary requirement for all large-scale research facilities. The Committee regards the continuity of SURFnet 6 and further e-science developments as vital, and advocates setting aside funding for this area in the next FES round. It would also point out the importance of the initiative taken by the European Alliance for Permanent Access, which aims to set up an organisational infrastructure in Europe providing permanent access to digital research data and scientific publications.[18]

Ancillary policy: legal measures

One of the biggest problems in setting up a European research infrastructure is the lack of suitable legal measures and the fact that the legislation varies from one member state to the next. It will therefore take a lot of time and effort to set up an international organisation for large-scale research facilities. The European Commission is tackling this problem by developing a legal framework for a European research infrastructure. The Commission published its proposals on 25 July 2008.[19] The discussion in Europe now centres on the possibility of creating a new legal structure, the European Research Infrastructure (ERI), which should make it easier for European research institutions to set up a joint organisation.

6. Recommendations

Short-term recommendations

1. Stick to the priorities set out in the Roadmap
The facilities covered in this Roadmap are divided into facilities listed in the 2006/2008 European Roadmap and facilities nominated for inclusion by Dutch research organisations.

Immediate political and financial support is being requested for eight facilities also listed in the European Roadmap. The Committee has advised the Minister to order NWO to use the sum allocated to it (EUR 63 million for the 2008-2012 period) specifically to finance these eight ESFRI facilities. The Committee is delighted that NWO is already complying with this recommendation. Should the funding prove to be inadequate, the Committee recommends examining whether the shortfall can be covered via one of the alternative financing mechanisms indicated. If such attempts are unsuccessful, then the Committee advises reserving a corresponding share of the available FES monies (a minimum of EUR 78 million) for the facilities covered in this Roadmap.

Immediate political – but not financial – support is being requested for five of the facilities also listed in the European Roadmap.

As for the remaining 12 facilities (three of which also appear in the European Roadmap), the Committee recommends making funds available via the FES or in the Interim Budget or 2009 Budget.

2. Develop the necessary ancillary policy when implementing the Roadmap
One of the considerations when deciding on the construction of new facilities is whether proper use can be made of such facilities. If a budget is allocated as part of a funding award, the Committee recommends calculating in an operational component for the first five to ten years of operation.

Large-scale research facilities involve more than money alone. They also require ancillary policy in the following areas:

- developing outstanding talent;
- encouraging collaboration;
- clustering;
- developing attractive employment terms;
- developing the ICT infrastructure;
- taking steps to introduce a legal framework for a European research infrastructure as quickly as possible.

3. Update the Roadmap in two years
The Roadmap is not a static document. It is important to reassess at regular intervals whether the choices made in the present Roadmap are still correct. The Committee therefore recommends updating the Roadmap in two years.

Medium to long-term recommendations

1. Subject the financing of large-scale research facilities to critical analysis
The new FES round (2009/2010) will proceed within the next few months. The Committee would like to see explicit emphasis given to the criteria 'proven willingness to collaborate' and open access in the decision-making on the new FES round on infrastructure projects.

The Committee advises the Minister to reserve a portion of the FES 2009/2010 round for large-scale research facilities, with funding being allocated on the basis of the transparent procedures advocated by the Expert Committee [Commissie van Wijzen]. It is also important to eliminate the overlap that the Expert Committee has noted between various successive or even simultaneous policy initiatives and measures that have largely the same policy aims and relate to the same activities.[20]

The Committee also advises the Minister to order the Rathenau Institute to assess the current and future expenditure on the Dutch research infrastructure or any foreign research infrastructure to which the Netherlands makes a major contribution. Finally, the Committee recommends that the Minister appoint a working group to assess the alternative forms of financing described in this report on their merits. The group would consist of representatives from the various ministries, trade and industry, the Expert Committee, the European Commission, the provinces, large companies and the JTIs and ERC.

2. Elaborate alternative financing arrangements
The research infrastructure has been funded primarily by means of incentive grants to date (some of these grants have been long-term and generous). Incentive grants have advantages from the researcher's viewpoint, but there are also disadvantages: a lack of continuity and no funds reserved for operational matters and replacement. Other EU member states are struggling with similar problems. The Committee therefore advises the Minister of Education, Culture and Science to have three alternative funding mechanisms elaborated:

a. A fund for research infrastructure projects, in line with the Innovation Platform's 2005 advisory report. The Innovation Platform estimated that the fund would require an annual input of EUR 125 million. The Committee believes that this is a realistic amount, and that it can be financed from FES interest income.
b. A specific budgetary line in the Ministry's budget, once again for EUR 125 million. This is the method used in such EU countries as Denmark, Germany, Spain and Sweden.
c. The same method used by the university hospitals, i.e. a building fund that receives a particular sum of money every year and in which building projects are prioritised. A fund of this kind would only work if a properly functioning umbrella organisation were set up.

Each of these three alternatives will ultimately result in the setting up of a structural fund to finance large-scale research facilities.

7. Brief description of the research facilities selected

Humanities and Social Sciences

*CLARIN (Common Language Resources and Technology Infrastructure) (level A)**

CLARIN (Common Language Resources and Technology Infrastructure) is a large-scale pan-European coordinated infrastructure intended to make language resources and technology available and useful to scholars in every discipline, in particular the humanities and social sciences. It will overcome the present fragmentation by harmonising structural and terminological differences based on a grid infrastructure, and by using Semantic Web technology.

There are enormous numbers of written texts (either continuous discourse or, for example, descriptions of objects of cultural heritage) and, more recently, recorded spoken texts available, and their number is growing exponentially. The sheer volume of this material makes the use of computer-aided methods indispensable for many scholars in the humanities and in adjacent areas who are concerned with language material.

The CLARIN Infrastructure aims to provide a comprehensive and easily accessible archive of language resources and technology, covering not only the languages of all the EU member states, but also languages and language issues related to migration.

The tools and resources will be interoperable across languages and domains. They will help address the issue of preserving and supporting Europe's multilingual and multicultural heritage. An operational open infrastructure of web services will introduce a new paradigm of distributed collaborative development and will allow many contributors to add new services, ensuring reusability and allowing scaling up to suit individual needs. CLARIN will preferably provide off-the-shelf tools and solutions and the necessary training and advice to customise the resources in order to suit the particular needs of humanities researchers. It will strengthen Europe's position in standardisation efforts, function as a pivotal and exemplary case for international initiatives, and help Europe to train young researchers not only to use the benefits of an infrastructure enabling eHumanities, but, more importantly, to contribute to it.

*ESS (European Social Survey) (level B)**

The ESS was set up in 2001 to monitor long-term changes in social values throughout Europe and produce data relevant to academic debate, policy analysis and better governance. It now covers thirty European countries. A long-term pan-European instrument such as the ESS requires long-term funding commitments. A major upgrade is now being sought to fill debilitating gaps in the present programme.

The ESS has a complex network of management and advisory committees, representing national teams and founders on the one hand, and academic specialists on the other. It covers the whole of the EU (apart from Malta), and includes both associated countries and a number of accession and candidate countries. It was built as a multi-funded enterprise. Its costs have been shared between the EC, the ESF, and 27 national academic funding bodies. Two-thirds of the ESS is now provided by the nations and one third by the European Commission. ESS data are published on the web as soon as they are available – with no prior 'privileged' access. This makes the publication of each dataset a major event in the European social science calendar.

The purpose of the proposed major upgrade is to unify, regularise and secure the funding for the RI as a whole over an extended period, though naturally with periodic reviews. A large and complex time series such as the ESS requires such continuity of funding, which is a prerequisite of appropriate planning. But a major upgrade would also help to fill debilitating gaps in the present programme of work and allow much-needed new programmes of work on:

- compiling and harmonising aggregate context variables for survey analyses;
- experimenting with alternative (technical and traditional) methods of translation to improve equivalence;
- investigating and mitigating longstanding problems in the collection and classification of occupation and education;
- improving the capacity to pilot and pre-test new questions on emerging issues of public concern;
- experimenting on a multinational basis with methods of improving response rates.

*SHARE (Survey of Health, Ageing and Retirement in Europe)***

SHARE (Survey of Health, Ageing and Retirement in Europe) provides a data infrastructure for fact-based economic and social science analyses of ongoing changes in Europe owing to the ageing of the population. The original eight-country survey has already being expanded to cover two new member states; ideally SHARE will be expanded to all 25 EU member states.

Preliminary data collection commenced in 2002, and 2004 saw the first wave of data being collected on the economic, health and family conditions of about 27,000 respondents aged 50 and over in eleven European countries. The participating countries covered all EU15 regions. The data is harmonised cross-nationally. The second wave of data collection is currently under way and includes Poland, the Czech Republic and Ireland. A third wave of data collection will focus on the life histories of the SHARE participants.

The first wave of SHARE data was collected in 2004, the second wave commenced in 2006, and further waves are envisaged bi-annually from 2008 onwards. In between these waves, experimental modules will be tested, such as the collection of life histories in 2007. The 24 months between the end of wave t and the end of wave t+1 can roughly be divided into 12 months of preparation and 12 months of data collection (including experimental modules). The SHARE data infrastructure is accessible free of charge through an archive operating as an Internet platform.

*DARIAH (Digital Research Infrastructure for the Arts and Humanities)**

DARIAH offers a platform for access to research material for the humanities in Europe (www.dariah.eu). DARIAH connects information users (researchers), information managers and information providers. It gives them a technical framework that enables enhanced data sharing among research communities. The changing nature of research practices in the arts, humanities and social sciences has created a pressing need for an international digital infrastructure. At the same time, developments in information and communication technology are generating exciting new opportunities for using just such an infrastructure.

DARIAH will contribute to innovation in arts and humanities research by:
- ensuring data can be found and accessed without the need for extensive travel;
- making innovative interpretation tools available to the research community;
- preserving data for future analysis;
- standardising tools and datasets to allow for interoperability.

The initiator and coordinator of DARIAH is Data Archiving and Networked Services (DANS, an institute of the KNAW and NWO). Sustained Dutch funding will strengthen the Netherlands' lead. Although DARIAH serves a wide range of research communities, such as archaeologists, linguists (through CLARIN), philologists and so on, 'DARIAH-Netherlands' will focus its activities primarily on social and economic historians through the CLIO-INFRAstructure (www.clio-infra.eu).

CLIO-INFRA was inspired by the need for a new data infrastructure for social science history. As a discipline, social science history is moving towards a pan-European and global approach to economic, social and demographic change, addressing fundamental societal questions (such as migration, social cohesion, economic growth, civil society, etc.). Researchers studying the long-term prospects of the growth regime that began with the Industrial Revolution in the late eighteenth century have questions not only about its emergence, but also about the spread and development of the process of modern economic growth. These concerns touch on the position of Europe within the world economy, its dynamics and competitiveness. Answering this new type of research question requires large amounts of quantitative and qualitative data on such themes as the structure of the world labour force, real wages, demographic developments and workers' movements. Moreover, techniques are required that make it possible to compare data gathered from different contexts and stored in distributed places. CLIO-INFRA will deliver the required data and tools in a next-generation international infrastructure, enabling efficient and innovative research. CLIO-INFRA encompasses e-collaboratories and corresponding data hubs in ten subject areas, four of which will be lead by Dutch Research Groups (at the universities of Utrecht and Groningen and at the International Institute of Social History), the others by partners elsewhere in Europe.

Among the ten data hubs, the Historical Microdata Centre (HMC) stands out. It will function as a centre of expertise for the broad field of social, demographic and economic history, making microdata accessible on individuals and households in Europe in the nineteenth and twentieth centuries. The Dutch data will be based on the Historical Sample of the Netherlands (HSN) and the GENLIAS index of civil certificates. It will build on existing networks of researchers and foster new comparative research in transnational studies by interconnecting with comparable data collections in Europe and beyond.

DISS (Data Infrastructure for the Social Sciences)

This proposal aims to reinforce the infrastructure of the social sciences in the Netherlands by promoting the conduct, methodology, enrichment and dissemination of social surveys in this country. The proposal simultaneously aims to improve established surveys and to generate ideal conditions for developing new initiatives.

Modern societies need valid and reliable data on individuals, social groups and businesses to develop science and government policy. The globalisation of the economy and of business, the internationalisation of political decision-making and cooperation, immigration and the ageing of the population are giving rise to questions concerning to the nature, determinants, effects and manageability of such trends. The answers can only be obtained through systematic and repeated data collection, internationally coordinated where possible in order to enhance comparability of results across societies. The data collected should be easily accessible for both scientific and policy-oriented purposes and be available in formats that maximise potential use.

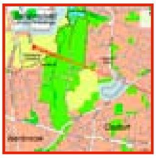
The survey questionnaire is undoubtedly the dominant method used to collect social data. The survey generates observational data (occasionally with embedded experiments) based on self-reports, supplemented by other modes of observation, and is collected from a sample of a well-defined population.

In the Netherlands, the overall picture with respect to data collection and dissemination using surveys is mixed. On the one hand, the Netherlands has a very strong tradition of designing and conducting surveys, both academic and policy-oriented. Repeated collection of core data in a variety of fields has already resulted in longitudinal datasets of internationally recognised quality. In 2007, a committee set up by NWO identified sixteen academic surveys that would merit continuation in the future, based on past performance, and this list could easily be extended to include several surveys conducted by Statistics Netherlands and the SCP. On the other hand, these surveys face a number of persistent challenges. It is these challenges that the present proposal intends to address in a uniquely cooperative endeavour by all the major parties involved in academic and policy-oriented survey research in the Netherlands.

This endeavour has involved an inclusive group of scientists working with academic and policy-oriented surveys in the non-profit sector. The main outputs of the proposed programme are:

1. A robust infrastructure for the continuous improvement of social science data in the Netherlands;
2. Efficiency gains achieved by conducting joint surveys (in part);
3. Standards for measuring a large number of common properties and concepts in surveys, as well as for implementing surveys;
4. Design standards for social surveys;
5. Effective corrections for non-response by linking survey data with register data;
6. Enrichment of survey data through links with data from other sources (registers, surveys);
7. Digitised historical data material; and
8. Production and dissemination of secure micro-datasets.

Natural Sciences and Technology

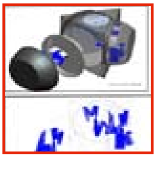


*European XFEL (X-ray Free Electron Laser) (level B/C)**

The European X-ray Free Electron Laser to be built in Hamburg, Germany, will be a world-class facility for the production of intense, short pulses of X-rays for scientific research in a wide range of disciplines.

The European X-ray Free Electron Laser (European XFEL) project foresees the construction near Hamburg, Germany, of a new international user facility for the production and scientific use of ultra-bright and ultra-short pulses of spatially coherent hard X-rays. The facility comprises a superconducting linear accelerator (1.7 km) that will accelerate electrons up to 17.5 GeV, distributing up to -30.000 electron bunches per second into three undulators. These will generate spatially coherent X-radiation pulses shorter than 100 fs in duration and, with peak power exceeding 10 GW, in a wavelength range from 0.1 mm to 1.6 mm. A further set of three undulators will generate hard X-rays down to 0.01 mm wavelength by the spontaneous emission process. The facility includes a set of ten experimental stations with state-of-the-art equipment for scientific use of the radiation.

It is anticipated that the availability of X-pulses with peak brilliance of up to nine orders of magnitude greater than existing third-generation light sources will make presently impossible and potentially revolutionary experiments possible in a variety of disciplines, ranging from condensed matter and materials physics to nanoscience and from plasma physics to chemistry, and will enable structural modifications at the atomic level on the sub-ps timescale during chemical reactions and phase transformations, the solution of macromolecular structures without the need for crystallisation, and access to presently inaccessible regions of the phase diagram of warm dense matter.



*E- ELT (European Extremely Large Telescope) (level B)**

Extremely Large Telescopes are regarded worldwide as one of the top priorities in ground-based astronomy. They will vastly advance our astrophysical knowledge, allowing detailed studies of inter alia planets around other stars, the first objects in the universe, super-massive black holes, and the nature and distribution of the dark matter and dark energy that dominate the universe. The European Extremely Large Telescope project will maintain and reinforce Europe's position at the forefront of astrophysical research.

Extremely Large Telescopes allow us to take the next major step in addressing the most fundamental properties of the universe. All aspects of known astronomy, from studies of our own solar system to the farthest observable objects at the edge of the universe, will be advanced by the enormous improvements attainable in collecting area and angular resolution. This is an opportunity to discover the new and unexpected, with detailed study becoming possible of the formation and evolution of planets, stars, galaxies, quasars, black holes, neutron stars, and the first objects to take form in the universe. We will gain a better understanding of the dark matter that is the dominant form of mass, and of the mysterious 'dark energy' that in turn controls the future of our entire universe.

ESO is presently developing the Reference Design for the European Extremely Large Telescope (ELT). Parallel to these efforts, the astrophysical community is developing and refining the ELT's scientific aim through the OPTICON FP6 programme, while European research institutes and high-tech companies are pursuing major enabling technologies within the ELT Design Study FP6 programme. These efforts are being conducted in close contact with other similar projects all around the world.

Astronomy is a technology-enabled science. Recent technology developments, especially in the real-time control of complex systems, have made it possible to build the next generation of telescopes. The light collection and spatial resolution (increasing from the present 8-10 metres to over 30 metres in diameter) will improve on current limits by tens to hundreds of times, providing the critical increase in sensitivity and resolution needed for truly outstanding scientific performance. Astronomical advances improve our understanding of mankind's place in the universe. Astronomy is known to attract young people to science and technology careers. As large precision opto-mechanical systems in hostile environments, astronomical telescopes spur on advanced technologies in many state-of-the-art areas, with spin-offs ranging from medicine to image data processing.

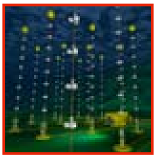
*ESS (European Spallation Source for Producing Neutrons) (level B)***

ESS will be the world's most powerful source of neutrons. Its built-in upgradeability (exceeding the initial twenty instruments, more power, more target stations) makes it the most cost-effective top tier source for forty years or more. A genuine pan-European facility, it will serve 4,000 users annually across many areas of science and technology.

Fine analysis of matter requires the complementary use of diverse 'probes' and techniques: light rays, neutrons, NMR, computer modelling and simulations, and so on. Intense beams of low-energy neutrons create entirely new opportunities, including recordings of nano-scale events, for real-time, real-size, in situ, in vivo and parametric measurements to elucidate the structures, dynamics and functions of increasingly complex inorganic and organic matter, biomaterials and systems. The ESS is a strategic project for Europe.

Neutron beams produced by reactors are inherently intensity-limited. The ESS R&D and design phase (more than EUR 50 million, encompassing all major European labs and with more than 100 top scientists) has shown the feasibility of MW spallation sources. In line with the global neutron strategy endorsed by OECD ministers in 1999, the US has now commissioned its facility based on the ESS design, and Japan will follow suit in 2007/2008. The initial long-pulse configuration of ESS provides substantially higher power, maximum complementarity and the largest instrument innovation potential. Its unique upgradeability guarantees a long-term top position. ESS will also offer new modes of operation and user support to provide maximum support for industry as well as university and research lab users.

The higher flux will allow advanced and more effective investigations of ultrathin and laterally confined structures for ICT reading devices, active site structures in enzymes, technologies for storing hydrogen, multicomponent complex fluids in porous media for tertiary oil production, the templating of nanostructures for catalysts, medical implants, pharmaceuticals, photonic materials, and so on. Requirements for novel detectors, instrument and software technologies will be additional drivers of innovation. ESS, a multifunctional facility with applications in many industries, will also have a marked regional impact (new firms in areas of regional specialisation, positive effect on regional as well as European talent pool, etc).



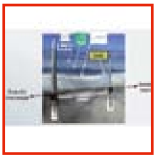
*KM3NET (Cubic Kilometre Neutrino Telescope) (level B)**

KM3NeT is deep-sea research infrastructure in the Mediterranean Sea that will be hosting a cubic-kilometre-sized deep-sea neutrino telescope for astronomy based on the detection of high-energy cosmic neutrinos and giving access to long-term deep-sea measurements

Because they are not deflected and can travel cosmological distances without absorption, neutrinos are ideal messengers for studying the highest-energy, most violent processes in the universe. However, due to their weak interaction with ordinary matter, they require huge detectors to measure them. The first generation of neutrino telescopes in the Mediterranean Sea is currently in operation or under construction. However, only future installations of cubic-kilometre size will exploit the full scientific potential of neutrino astronomy. These installations can be built in synergy with environmental observation underwater stations.

The KM3NeT neutrino telescope will be the leading European facility for neutrino astronomy. It will be the only deep-sea installation of this size in the world, its single counterpart being the US-led IceCube project that is being installed in the Antarctic ice at the South Pole. KM3NeT will determine the direction and energy of the neutrinos with greater precision than to IceCube; it will also have a lower energy threshold for neutrino detection and the major advantage of being able to observe neutrinos originating from the central region of the Milky Way. The design of the KM3NeT neutrino telescope poses substantial challenges with respect to photo-detection, data acquisition and processing, deep-sea technology, installation and maintenance procedures, cost effectiveness and stability of operation. These issues are addressed in a FP6 Design Study (2006-2009), building on technology at the forefront of science.

KM3NeT will be a truly interdisciplinary research infrastructure: it will give the astronomy, astrophysics, astroparticle and particle physics communities access to neutrino observation and, in addition, allow for long-term measurements in deep-sea environments that are of the utmost interest to biologists, geophysicists and oceanographers.



*PRINS (Pan European Research Infrastructures for Nano-Structures)***

The Pan-European Research Infrastructure for Nano-Structures (PRINS) is the Research Infrastructure arm of a broader initiative, the ENIAC European Technology Platform.
PRINS will bridge the gap between research and market-driven applications and provide Europe with the ability to master the revolutionary transition from microelectronics to nano-electronics, i.e. down to the level of individual atoms.

PRINS has been conceived as a distributed infrastructure based in three European countries (Belgium, France and Germany) that will address the new challenges in a coordinated and complementary effort. Three pre-existing centres of excellence (IMEC, CEA-LETI and Fraunhofer Microelectronics Alliance, respectively) will share a common umbrella structure providing academic access. The types of access and the related conditions are explained in more detail in the PRINS Concept Document of 25 January 2006. These three scientific and technical integration centres will be supported by a complementary network of flexible rapid-prototyping laboratories. Their role will be to validate innovative device and material steps in the nanoscale CMOS and beyond CMOS areas.

The PRINS research infrastructure will enable European research into the ultimate scaling of electronic components ('Moore's Law'), the combination of digital signal processing with other types of functionality ('More than Moore'), the exploration of novel device concepts ('Beyond Moore') and the integration of components and materials into systems in a package (SiP).

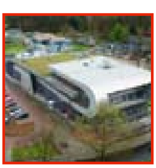
PRINS will contribute to achieving the goals of the ENIAC Strategic Research Agenda. PRINS will bring together an unprecedented array of equipment and know-how on topics such as high-resolution lithography, advanced process steps and modules, electronic systems integration, imaging devices, silicon-based micro-systems, and miniaturised devices addressing the nano¬bioconvergence. It will boost European RTD performance in nano-electronics and combined nano-structures. The applications that PRINS will generate will serve the future demands of European society, increase high-skilled employment, reinforce the competitiveness of European industry, and secure global leadership in high-tech multidisciplinary research.

*SKA (Square Kilometre Array) (level B)***

The Square Kilometre Array will be the next-generation radio telescope. With an operating frequency range of 0.1 – 25 GHz and a collecting area of about 1,000,000 m2, it will be fifty times more sensitive than current facilities. With its huge field-of-view, it will be able to survey the sky more than 10,000 times faster than any existing radio telescope. The SKA will transform our view of the universe.

The development of radio telescopes and radio interferometers in recent decades has helped drive the continuous advancement in our knowledge of the universe, its origins and evolution, and the enormously powerful phenomena that give rise to star and galaxy formation. Radio astronomy also provides one of the most promising search techniques in humanity's quest to determine whether life exists elsewhere in the universe.

The huge collecting area of the SKA will result in a sensitivity fifty times greater than any existing interferometer, a requirement for seeing the faint radio signals from the early universe. The radically new concept of an 'electronic' telescope with a huge field-of-view and multiple beams will allow very fast surveys. The SKA will be the most sensitive radio telescope ever built and will attack many of the most important problems in cosmology and fundamental physics. Observations of pulsars will detect cosmic gravitational waves and test Einstein's General Theory of Relativity in the vicinity of black holes. The SKA will study the distribution of neutral hydrogen (the most common element in the universe) in a billion galaxies across cosmic history, making it possible to map the formation and evolution of galaxies, study the nature of dark energy, and probe the epoch when the first stars were born. The SKA will be the only instrument that will map magnetic fields across the universe, allowing us for the first time to study the nature of magnetism. Last but not least, the SKA will study the formation of planetary systems and explore whether life exists elsewhere in the Universe.



*HFML (High Field Magnet Laboratory)**

The new HFML (High Field Magnet Laboratory), with facilities for high continuous and short pulsed magnetic fields, opened in Nijmegen in 2003. The facility has an active local user group and is available to external users both in the Netherlands and from outside the country. Roughly one third of its capacity is used by the local group and two thirds by external users, the majority of whom are from outside the Netherlands. The present level of funding allows for 1000-1200 measuring hours per year, which is half of the HFML's technical capacity. This limited use of the facility is regrettable, since no maximum benefit is being derived from this unique and desirable – demand exceeds the capacity by a factor of two – but also costly resource. Consequently, request for magnet time cannot be met, progress is delayed and important projects suffer. This proposal seeks funding to double the number of operating hours, upgrade the facility and make novel advanced experiments on nanosystems possible by constructing a special vibration-free 40T hybrid magnet for nanoprobing experiments at single molecule or nano-object level. This project would require an investment of EUR 17 million and another EUR 3 million/year in operating costs. With this financial basis, the HFML would be well placed to profit maximally from previous investments and to play a dominant role in research on high magnetic fields in the decades ahead.

Magnetic fields are a unique tool for acquiring an essential knowledge of materials, since a magnetic field exerts a controlled influence on all forms of matter. Studying materials in high magnetic fields is one of the most effective ways of establishing their properties. Much of the research on high magnetic fields is pioneering in nature and reveals new properties at a very early stage of material development. These pioneering discoveries often lead to new materials and applications that can be exploited later in much more practical environments.

Researchers in the life sciences, chemists and physicists increasingly use the most modern synchrotron radiation facilities, free electron lasers, neutron sources, advanced telescopes, satellites and also high magnetic fields. Most of these multi-user facilities are in countries that can afford to construct and operate such large installations, with a modest degree of participation by the Netherlands. The HFML is one of the few fully Dutch facilities that can and does compete on an international scale. The laboratory is one of four worldwide (the other three being in Tallahassee, Grenoble and Tsukuba) that can produce the highest continuous magnetic fields and make them available for a broad user community. The recent investments in the HFML (EUR 23 million) together with the ongoing programme to construct a free electron laser coupled to the HFML magnets and to build a 45T magnet (the EUR 27 million NWO-Big grant for the Nijmegen Centre for Advanced Spectroscopy, NCAS) make the laboratory a world player and essential partner for European developments in the field.

NanoLab

NanoLab NL provides a coherent and accessible infrastructure for nanotechnology research and innovation in the Netherlands. Nanotechnology infrastructures are crucially important for the 3TU Centre of Competence Applications of Nanotechnology. NanoLab NL is directly related to PRINS, the facility recognised by the European Strategy Forum on Research Infrastructures.

NanoNed, the nanotechnology network of the Netherlands, is an initiative undertaken by eight research institutes and Philips. It pools the nanotechnology and enabling technology capabilities of the Dutch industrial and scientific nanotechnology knowledge infrastructure into a single national network. This network facilitates rapid gains in knowledge through vital research projects, the infrastructure investment programme NanoLab NL and the economically relevant dissemination of knowledge and expertise, resulting in high added-value economic growth.

NanoNed recognised the importance of a national facility and was one of the main drivers and contributors to the budget required to establish NanoLab NL. NanoLab NL seeks to bring about coherence in the national infrastructure and in access and the tariff structure. Its lab facilities provide Applications of Nanotechnology (one of the 3TU Centres of Competence) and its partners with an indispensable infrastructure essential to remaining a world player in this field.

At the launch of NanoNed, the partners decided to allocate infrastructure funding to three locations in the Netherlands where large nanotechnological facilities were already in place. These locations are spread across the country. They complement one another in their fields of activity and expertise, and offer the widest possible spectrum of nanotechnology facilities available to researchers in the Netherlands. The partners offer a combination of basic facilities and expert functions, the latter being allocated to a specific member in the consortium on the basis of their proven expertise.

Starting in 2004, when NanoLab NL was established, until the end of 2009, the NanoNed NL partners will invest about EUR 110 million in nanotech facilities (through their own funding and through additional public funding, mainly BSIK). The NanoLab NL partners have demonstrated their long-term commitment by establishing a reinvestment fund, which represents 10% of the overall investment funding for equipment.

Since NanoNed's establishment, major progress has been made not only in the field of nano-electronics but also in nano-structured materials science, enabling technology for a broad variety of functional nanostructures and applications in the life sciences and sustainable energy. To maintain and improve the leading position of NanoLab NL in Europe, new investments are needed. The interface between nanotechnology, the life sciences and environmental science offers fascinating opportunities, for example. In addition to new investment, maintaining the current NanoLab NL facilities involves replacing some equipment as well as meeting the technical support and operating costs for this national facility.

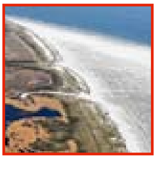
Environmental Sciences and Energy

*ICOS (Integrated Carbon Observation System) (level B)**

ICOS (Integrated Carbon Observation System) is an infrastructure for co-ordinated, integrated, long-term high-quality observational data on the greenhouse balance of Europe and of adjacent key regions of Siberia and Africa. Consisting of a centre for coordination, calibration and data handling in conjunction with networks for atmospheric and ecosystem observations, ICOS is designed to create the scientific backbone for a better understanding and quantification of greenhouse gas sources and sinks and their feedback with climate change.

Unlike meteorological parameters that have been routinely collected by meteorological services for fifty years and for which global satellite observations have existed for thirty years (with secure commitments for the future), there is no coordinated system to measure atmospheric greenhouse gas concentrations in Europe. Only about half of the anthropogenic CO_2 emissions accumulate in the atmosphere, while the remainder is taken up by land and oceans, on average in similar proportions. However, these sinks vary widely in time and space. Informed policy decisions depend on our ability to quantify present-day carbon sources and sinks and understand the underlying carbon mechanisms, a fundamental requirement for developing strategies to manage carbon emissions.

In order to predict the response of the earth system to global change, we must have a better understanding of vulnerability and regional feedbacks between climate and biosphere. It will not be possible to address research priorities in the field of global and regional climate-biosphere feedbacks without dense, consistent, long-term, integrated observations of trace gases and relevant environmental tracers and ecosystem parameters such as those provided by ICOS. The ICOS observational data and secondary data products form the basis for better understanding and adequate human action. ICOS will significantly enhance the observational basis and accessibility of observational data to the benefit of the applied and basic scientific community.



*LIFE WATCH (Research Infrastructures Network for Research in Biodiversity) (level B)**

LIFE WATCH will construct and operate the facilities, hardware, software and governance structures for research on the protection, management and sustainable use of biodiversity. It will consist of facilities for data generation and processing, a network of observatories, facilities for data integration and interoperability, virtual laboratories offering a range of analytical and modelling tools, and a Service Centre providing special services for scientific and policy users, including training and research opportunities for young scientists. The infrastructure has the support of all major European biodiversity research networks

Changes in biodiversity are having a serious impact on the capability of European ecosystems to provide essential services, which in turn affects the quality of life of individuals and the social and economic aspects of sustainable development. It is increasingly important to develop novel approaches to understanding and sustainably managing our environment so that spatial requirements for human activity and for protecting the natural environment are balanced. EU projects and GBIF have made much progress in providing access to interoperable databases, but large-scale analytical and modelling cannot benefit fully from these resources. Targeted collective action is needed to accelerate data generation and to bring data and services into a virtual analytical modelling laboratory environment. There is now an urgent need to complement remote earth observations (GMES, GEOSS) with a biodiversity infrastructure covering ground-level terrestrial and coastal marine ecosystems, species-level and genetic components.

LIFE WATCH will boost progress in many areas. Biodiversity is a cross-border phenomenon, and the pan-European approach of this facility will lead to major synergies. The new infrastructure will integrate the full potential of taxonomic (collection-based) and ecosystem information with genomic data from other sources in an international virtual laboratory environment. The wealth of large datasets from different (genetic, population, species and ecosystem) levels of biodiversity opens up new and exciting research opportunities. Comparative data mining in large-scale datasets makes it possible to study patterns and mechanisms across different levels of biodiversity. The large-scale approach allows us to understand (and manage) the impacts of climate change (such as changing precipitation patterns, droughts and fires, storms, rise in sea level and so on) on the distribution, adaptation and functions of biodiversity. Complex and multidisciplinary problems require scientists to collaborate in virtual organisations. Biodiversity e-Science enables 'distributed large-scale' research. This will be the only way to participate in new scientific developments in this area. The facility will support the research necessary to meet the policy objectives set out in the EC Communication 'Sustaining ecosystem services for human well-being' (2006) and is a major component of the European contribution to GEOSS.

EWAC (European Water Assessment Centre)

As a low-lying coastal area, the Netherlands is threatened by the water and benefits from it. To ensure its safety and exploit these benefits, the country has acquired an extensive knowledge of water systems and water management, serving the interests of a wide variety of economic sectors as well as sustaining ecological objectives. Throughout the centuries, natural extremes in the hydrological cycle, such as droughts and floods, became more important as society became more vulnerable to them. At the same time, population growth and economic progress made society more dependent on its water resources, with rapid urbanisation, industrialisation and intensive farming resulting in an increasing demand for water.

KNMI, Alterra, Deltares, TNO, Kiwa Water Research, Delft University of Technology, Wageningen University and Utrecht University are all leading, internationally recognised centres of excellence on various aspects of water systems, including modelling and simulation of both natural and man-made systems. These organisations propose to initiate an internationally recognised centre for water assessment by combining their expertise and further developing their joint knowledge. The aim is to create a virtual centre of excellence on the natural (hydrological) and man-made (technological) water cycle that will act as a tool for science and provide a solid scientific background for policy-oriented questions and the operational management of natural water resources and urban water cycles.

One of the critical success factors for achieving this is the capability to integrate the specific models, databases and innovative technologies from the different domains. An ICT architecture is required to facilitate integration at the information, processing and visualisation level. Another critical factor is the availability of pilot testing facilities to verify innovative concepts and technologies for the urban water cycle.

The centre's main goals would be:

1. to develop and provide for tools (i.e. integrated models and databases) to support day-to-day water management, water supply and waste water treatment;
2. to develop tools (i.e. integrated models and databases) to assess the consequences of natural and human-induced changes in the hydrological cycle for water management and public health, such as the structural degradation of aquifers, large-scale interventions in surface runoff and buffering, the rise in the sea level, and changes in precipitation, temperature and wind;
3. to forecast and monitor droughts and floods on a daily to seasonal timescale and to develop early warning systems for hydrological extremes, tailored to relevant economic sectors such as water management, water and waste water utilities, energy, agriculture, transport and tourism, with the aim of increasing preparedness for extreme events;
4. to develop innovative solutions to the technological challenges of providing drinking water and waste water utilities in more extreme hydrological conditions. These challenges relate to all aspects of the technological water cycle (water supply, sewage collection, waste water treatment);
5. to develop and implement a framework for integrating the models and databases and to provide an infostructure, i.e. the infrastructure and supporting services for processing models, storage for data and control room-like visualisation of operational and simulated data;
6. to set-up an organisation to maintain and expand the above infostructure to include additional information sets and models.

TFLAB (Dynamic Two Phase Flow Laboratory)

MARIN wants to invest in a Dynamic Two Phase Flow Laboratory (TFLAB) to:

- create research capabilities to study ship propeller performance in waves and wave loads and impacts on vessel structures in correctly modelled conditions;
- use these capabilities to:
  1. gain insight into the ventilation and performance degradation of ship propellers in waves and, by understanding this, contribute significantly to the efficiency of the ship propulsion system, a relevant topic with the enormous emphasis being placed on fuel consumption and emissions reduction.
  2. investigate the phenomena related to the wave loads and wave impacts on ships and new materials and understand the effects on the structural design, resulting in safer ship and cargo hold designs. This has become more relevant in view of recent accidents and the more extreme climate conditions of the past few years.
  3. investigate air lubrication in operational conditions, gaining insight into the possibilities, and, if successful, taking a major step forward in ship resistance reduction and fuel consumption.
- support the maritime sector to improve the safety of shipping and offshore activities, and improve the competitiveness of shipping as an economically viable and environmentally friendly alternative to road and rail transport;
- broaden and maintain MARIN's unique and leading position in the world based on research, development and innovation and use this position to strengthen the position of the Dutch maritime sector in the international market.

The investment in the TFLAB adds new functionality to an existing infrastructure, the Depressurised Towing Tank, already in use by MARIN. This facility is 240 m long, 18 m wide and 8 m deep and can be depressurised to 25 mbar. The facility will be equipped with wave makers on two sides to be able to generate short-crested multidirectional waves. By adding these wave makers, and the necessary oscillation and measuring systems, the facility gains the unique ability to investigate the wave impact on ships with reduced air pressure and the cavitation and ventilation behaviour of a ship propeller in waves. The facility will also be equipped with a large oscillation platform with six degrees of freedom to study the fluid motions and impacts in large-scale cargo holds or tanks. The TFLAB new capabilities will also enable research into wave loads and impacts on vessels with correctly scaled air entrapment, LNG, water or liquid sloshing, a very complex two-phase flow problem and air lubrication, ventilation and cavitation in waves, an area that is poorly understood as yet.

These research areas are important for the Dutch maritime sector, which plays an important role in offshore deep-water oil and LNG transport and in the design, building and use of complex and special ships. The sector wants to maintain its leading global position and one of the key factors for achieving this is innovation. The sector was recognised by the Innovation Platform as one of the key innovative areas in the Netherlands and an innovation programme is currently in its second year. The strategic research agenda for this programme include the following research areas; sloshing phenomena, hydrodynamic behaviour of LNG tankers, new materials, hydrodynamic behaviour mooring systems, swell response, new ship concepts, improved reliability of service, and reduction of fuel consumption and emissions. These research priorities have a close relationship with the TFLAB capabilities. The topics covered by the Flab's capabilities are also closely related to European Framework research projects on air lubrication, propellers in service, safety and Short Sea Shipping.

NCB (Netherlands Centre for Biodiversity)

With global biodiversity under serious threat and innovative research opportunities rapidly expanding thanks to unprecedented technical advances, the Netherlands is uniquely positioned to capture a prime spot in the burgeoning field of biodiversity science. Bringing together several world-class specimen collections, the Netherlands Centre for Biodiversity (NCB) will instantly house the world's fifth largest natural history collection, making it an international magnet for research aimed at understanding, preserving and fully exploiting the planet's Tree of Life.

The NCB mission is to be an open archive of life's diversity dedicated to reconstructing and understanding the Tree of Life, to educating people about our natural world, and to raising awareness of the sustainable use of the earth's living resources. The NCB will have two foundations – its top collections and its international reputation in systematics research. By developing other novel molecular and digital techniques and by working closely with Dutch and foreign partners, including those from well-established European networks, the NCB will grow into a powerhouse of biodiversity research and a key supplier of tools that will be used throughout society. For example, the Centre will be responsible for major parts of the global endeavour to create 'DNA barcodes' for millions of species.

Knowing and halting the decline of global biodiversity currently ranks among the world's most pressing challenges. The Dutch government, in its Biodiversity Policy Programme 2008-2011, spelled out several priorities in the area, one of which was knowledge, including research. The programme mentioned three key priorities in that respect:
– An adequate knowledge infrastructure;
– Better access to and use of expertise;
– Targeted policy-supporting and applied research.

The policy document also stressed the need to raise public awareness about and improve the visibility of biodiversity through communication and education, and supported the creation of the EU Program Life Watch. It recognised that the Netherlands has a strong starting position in biodiversity research and information, and saw 'clear opportunities for a larger international role' for the country. All of this perfectly reflects the aims of the Netherlands Centre for Biodiversity.

The Netherlands Centre for Biodiversity will:

- merge and preserve a number of unique specimen collections into one repository that will rank fifth in the world in terms of size and quality;
- catalogue this precious archive by state-of-the-art morphological, molecular, imaging and digital techniques, and making its content accessible for researchers worldwide;
- attract top researchers to capitalise on the treasure trove by exploring new research questions and using new tools such as genome and transcriptome sequencing and metabolomics in an advanced laboratory setting;
- become a European centre of expertise for global phylogeny research that will help shed light on the dynamics of biodiversity;
- together with the Fungal Biodiversity Centre (CBS) in Utrecht, become a European centre for DNA barcoding by integrating taxonomic expertise and molecular characterisation to ease and to accelerate taxonomic identification.

Second generation solar energy technology laboratories

The goal of this proposal is to expand ECN's current solar energy research laboratories with the addition of a second generation laboratory in order to strengthen ECN's prominent position in the field of photovoltaic solar energy (PV).

ECN has an extensive network of solar energy laboratories. Most were built and furnished between ten and fifteen years ago and have been very successful in helping create one of the most respected research programmes in the world. Because they were founded at a particular stage in the development of the solar energy sector, the laboratories focus mainly on small-scale experiments and simple process steps. Since that time, however, the sector has undergone significant growth, production has increased by one to two orders of magnitude and complex processes and device structures (including those for high efficiency) have become the norm. In addition, completely new technologies, such as organic solar cells, have made their appearance. Research must of course follow such developments or, preferably, be ahead of them. Although ECN has been able to take small steps in the right direction in recent years, it has not yet been able to make the large investments required. The Netherlands is therefore lagging significantly behind other countries such as Germany and France, where government support has made it possible to construct large new facilities recently. These facilities are specially designed to meet the latest demands and requirements, creating a highly unlevel playing field in Europe. Technological innovation in the field of photovoltaics is only possible if tests can be performed and demonstrations given on a relevant, i.e. sufficiently large, scale (area and throughput). The breadth of the demand and the complexity and diversity of the devices also makes it necessary to have a range of techniques and processes available. It is therefore vital for ECN to make a significant investment in its solar energy laboratories, and soon, in order to be able to continue the success of the past.

Photovoltaic solar energy research is perfectly suited to investment, in part because the Netherlands has a prominent international position in this area, but also because it is of global significance (i.e. sustainable energy) and is a field that attracts talented young Dutch and foreign researchers.

*European Biobanking and Biomolecular resources (level A)**

This facility is a pan-European and broadly accessible network of existing and de novo biobanks and biomolecular resources. The infrastructure will include samples from patients and healthy persons, molecular genomic resources and bioinformatics tools to optimally exploit this resource for global biomedical research.

Following the rapid progress of genomic research into humans and their ancestors, biomedical and health research has expanded from the study of rare monogenic diseases to common, multifactorial diseases. However, most complex diseases are elusive, as they are not rooted in single defects but are caused by a large number of small, often additive effects of genetic predisposition, lifestyle and environment. Discovery, i.e. separating the signal from the noise, depends on studying large collections of well-documented, up-to-date epidemiological, clinical and biological information and accompanying material from large numbers of patients and healthy persons. Such biobanks are widely considered as a key resource in unravelling the association between disease subtypes and small, but systematic, variations in genotype, phenotype, and lifestyle.

This project aims to build a coordinated, large-scale European infrastructure of biomedically relevant, quality-assessed sample collections in order to improve the treatment and prevention of common and rare diseases, including cancer. In this area of unique European strength, valuable and irreplaceable national collections typically suffer from underutilisation owing to fragmentation. Major synergies, statistical power and economies of scale will be achieved by interlinking, standardising and harmonising – and sometimes even just cross-referencing – a large variety of well-qualified, up-to-date, existing and de novo national resources. The network should cover: (1) most human blood, sample and DNA banks, (2) molecular resource centres for human and model organisms of biomedical relevance, (3) bioinformatics centres to ensure that databases of samples in the repositories are dynamically linked to existing databases and to scientific literature.

*EATRIS (European Advanced Translational Research Infrastructure for medicine)***

EATRIS (European Advanced Translational Research Infrastructure in Medicine) will first establish a small number of research facilities distributed in Europe, its task being to translate basic discoveries into clinical practice. Each node of the network will include cutting-edge technologies for translational research and will cover one of the major disease fields: cardiovascular diseases, cancer, metabolic syndrome, brain disorders and infectious disorders. In later steps, additional dedicated centres are expected to join the EATRIS partnership.

Despite tremendous progress in the life sciences and the pharmaceutical industry's growing investment in research and development, we are observing a widening gap between discovery and translation into medical products and applications. New results from basic science are not translated into clinical practice and patient care, or the translation is slow and incomplete. Translation of laboratory findings into diagnostic, therapeutic and preventive clinical applications indeed poses a major challenge for modern biomedical sciences. It requires considerable know-how and infrastructure to achieve preclinical development in such areas as the identification of target molecules, novel biomarkers, assays, the screening of molecular and chemical libraries, diagnostic procedures, genebased therapies, medicinal and computational chemistry, antibody production, in vitro and in vivo validation, toxicological analysis and the production of therapeutic agents under Good Manufacturing Practice conditions. This challenge can only be surmounted in a dedicated translational R&D infrastructure that links and engages both clinical and basic scientists as well as strong industrial partners.

As a first step, a small number of European centres dedicated to translational research will be established, interacting closely to constitute the core of EATRIS. The five to ten centres will offer pan-European access, encompass interdisciplinary expertise, and focus on the following major areas, chosen because they cover some of the largest and most important disease categories in Europe: cancer, diseases of the cardiovascular system, brain disorders examined by advanced imaging, metabolic syndrome and infectious diseases studied using high-security laboratories. The centres will be model centres that develop joint programmes for translation, clinical validation, data management, quality assurance, monitoring/auditing and training, education and exchange. They will establish close links with the Network of Distributed Infrastructures for Clinical Trials in Europe and programmes for early diagnosis and prevention, as well as access the European Biobanking and Biomolecular Resources Infrastructure and Bioinformatics Infrastructure for Europe. During later stages, additional dedicated centres are expected to join. The European Union needs this strategy in order to secure an international top position in the most important fields of translational medical research. It will also considerably strengthen the economic potential of health care markets in Europe.

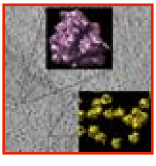
*European Biomedical Imaging Infrastructure, from Molecule to Patient: Euro-BioImaging**

Euro-BioImaging brings together key research areas in the imaging field, stretching from basic biological imaging with advanced light microscopy to the clinical and epidemiological level with medical imaging. Euro-BioImaging will address the imaging requirements of both basic and medical imaging communities by creating a coordinated and harmonised plan for infrastructure deployment in Europe.

Euro-BioImaging will be organised into closely interlinked nodes, each one focusing on complementary imaging technologies that address different aspects of biology, physiology and pathophysiology. These nodes are:

– Common Nodes: Large-scale image processing and computing, databases for quantitative biomedical imaging, and imaging of tissues and animal models;
– Advanced light microscopy nodes;
– Medical imaging nodes, including population imaging.

The Netherlands is strong in imaging and has interesting and compliant study populations. Adding imaging data to the genetic, lifestyle and other phenotypic information available on the populations will offer novel research opportunities. The aim is for the Netherlands to host the node for population imaging within Euro-BioImaging, for which we are in an excellent position. To strengthen this position, we propose to expand the research facilities for population imaging with dedicated, state-of-the-art imaging units and data handling and processing capacity. This will create an infrastructure for population-based research that is unique in the world, enhancing the Dutch science position and benefiting industry. The benefits to society are reduced health care costs (those at risk will be identified) and a higher quality of life for patients (thanks to new diagnostic markers and therapeutics). This proposal is broadly supported by the Netherlands Federation of University Medical Centres (NFU).



NeCEN (Netherlands Centre for Electron Nanoscopy)

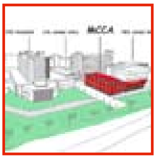
The Netherlands Centre for Nanoscopy (NeCEN) is a facility based on a powerful combination of three different types of cryo-transmission electron microscopes (cryo-TEMs) designed specifically to explore the complex structures inside cells at a hitherto unknown level of detail and – even more importantly – in a close-to-native state. Visualisation of cellular processes on this scale and under such realistic conditions will lead to scientific breakthroughs and to new possibilities in the prevention, diagnosis and treatment of cancer and infectious, neuro-degenerative and cardio-vascular diseases. A recent example of how nanoscopy increases our understanding of disease is the discovery of the life cycle of Mycobacterium tuberculosis, a study that will eventually lead to new vaccines and drugs to combat this widespread disease.

On a national level, NeCEN will fuel scientific developments in key areas of scientific research by offering beyond-state-of-the-art nano-scale imaging capabilities. Examples of these key areas are:
– Life Sciences and Genomics – current research clusters include the Cyttron Programme and the recently launched Centre for Translational Molecular Medicine (CTMM; early diagnosis and targeted therapies) and the BioMedical Materials Programme (co-polymers, material properties at the nano-level);
– Micro- and Nanotechnology/High Tech Systems – research topics including nano-structures with new functionalities such as bio-compatible MEMS, memory-chips and microprocessors;
– Chemistry and Energy – more specifically research programmes aimed at (low-cost) photovoltaics and the replacement of fossil fuels by agricultural products (bio-based economy).

On a European level, NeCEN's infrastructure is a response to the EFSRI initiative in integrated structural biology and the Network of Excellence 3D Electron Microscopy. NeCEN has the potential to become one of the major centres in these and other European research networks.

Renowned TEM manufacturing company FEI is a partner in NeCEN and will fabricate the high-end cryo-TEMs in Eindhoven, all based on the innovative Titan platform. Currently, only two Titan high-throughput cryo-EMs exist, one of which has already generated remarkable results. Three cryo-TEMs will be working together at NeCEN: one will be equipped for high-throughput single particle analysis; the second for high-throughput cryo-electron tomography; the third will be used for the development of new cryo-microscopy methods and instrumental innovations such as better image detectors, phase plates combined with Cs correctors to reduce beam damage/ increase contrast and resolution. The triple approach is key to the success of NeCEN. Together with the strength of the consortium and its approach to setting up the centre, it defines why NeCEN has added value compared with individual TEM centres in the world.

The centre will also be equipped for specimen preparation under Biosafety Level 3 conditions. Supporting instrumentation will include cryo-light microscopes, including phase contrast options to perform correlative microscopy, dedicated infrastructure for fast data
processing, data storage and visualisation and an option for outside users to perform remote electron microscopy. The NeCEN will be unique in the world for its ability to study infectious micro-organisms and diseases with a genetic component, such as cancer.



MCCA (Mouse Clinic for Cancer and Ageing research)

The mouse has proven to be an excellent system for studying the role of genetic and environmental factors in cancer and ageing in an intact organism. In the past decade, modelling of disease in genetically engineered mice has become increasingly important and has resulted in important breakthroughs in our understanding of the molecular basis of cancer and ageing (premature). The Netherlands has played a prominent role in developing and using genetically engineered mouse models for cancer and ageing syndromes and has a leading position in Europe in this area. However, maintaining and further expanding this prominent will require a critical investment in new technologies, for several reasons. A national facility must be established in which all this expertise is concentrated. Such a facility will offer researchers in the Netherlands the opportunity to maintain and improve on their prominent position and encourage collaboration with laboratories in other European countries that are also active in cancer and ageing research.

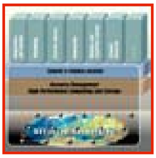
The Mouse Clinic for Cancer and Aging research (MCCA) should encompass four key areas of expertise:

1. A core facility for efficient production, cryopreservation, rederivation and distribution of compound conditional transgenic and knockout ES cell lines for production of F0 ES cell-mice.
2. Ability to perform intervention studies, including genetic interventions (using RNA interference), image-guided radiotherapy (using a small animal cone-beam irradiator), chemotherapy and targeted therapy with small molecules.
3. Imaging techniques (MRI, CT, PET, SPECT, ultrasound, optical and intravital imaging) for longitudinal monitoring of disease development and therapy response in mice.
4. Infrastructure and expertise for comprehensive and standardised phenotyping of mouse mutants in the fields of clinical chemistry, hematology, immunology, neurology, (steroid) metabolism and endocrinology, molecular profiling, histology, immunohistochemistry and pathology.

This approach is complementary to ongoing European programmes establishing a resource of mouse strains carrying single gene modifications. The proposed facility will take advantage of these programmes by utilising the ES cell lines they generate as a starting point for further genetic modification. Another consideration is that a number of European institutes are eager to join this effort but are unable to launch a large initiative of this kind on their own. Their presence will create a strong European consortium that will allow the Netherlands to maintain its competitive edge and create the conditions to attract new talent. We envision that such a joint effort will also permit us to attract European funding to continue and expand this important service.

A facility as described above cannot exist on its own; it needs to be part of a large research entity that already exploits a dedicated mouse facility providing all the supportive infrastructure vital to the MCCA. There is now a unique opportunity to incorporate the MCCA into a new animal facility that will be built by the Netherlands Cancer Institute (NKI). The MCCA will be constructed as a negative barrier unit, permitting external investigators and mice to enter the facility without restriction. This requires a completely separate entity within the confines of the new animal facility. This plan fulfils two of the three aims to which we have committed ourselves: the reduction and refinement of animal use. The MCCA therefore meets three important societal needs: improving the treatment of cancer and debilitating diseases of the elderly and maximising the information that can be obtained from experiments with as few animals as possible.

E-Science



Towards a National ICT Research Infrastructure

This proposal concentrates on creating and maintaining an advanced ICT research infrastructure in the Netherlands. It includes networks, computing and storage hardware, and the middleware and generic services needed to enable modern research. Given the importance of international cooperation in modern science, the infrastructure will be connected to other initiatives worldwide.

Appendix 1 Roadmap Committee members

W.G. Van Velzen, chairperson
Prof. W.J. van den Akker
Prof. J.A.M. Bleeker
Dr K.H. Chang
Prof. J.C. Clevers
Dr W. van Drimmelen
Prof. L.J. Gunning-Schepers
Prof. L. Hordijk
Prof. J. Joosten
P.J.J.G. Nabuurs
Prof. D.N. Reinhoudt
Dr I. Stoop
Prof. W. van Vierssen

N.R.J. Deen acted as the Roadmap Committee's secretary.
Dr J.W.A. Ridder-Numan (Ministry of Education, Culture and Science) and H.J.T. Nieuwenhuis (Ministry of Economic Affairs) functioned as observers.

Appendix 2 Resolution Inaugurating the Roadmap Committee

Resolution inaugurating the National Roadmap Committee for Large-Scale Research Facilities

09 JULY 2007

Regulation by the Minister of Education, Culture and Science of no. OWB/WG/2007/24460, determining the inauguration of the National Roadmap Committee for Large-Scale Research Facilities (Resolution inaugurating the National Roadmap Committee for Large-Scale Research Facilities).

The Minister of Education, Culture and Science,

hereby resolves:

<u>Article 1 Terms</u>
In this Resolution, the following terms will be understood to have the meanings assigned to them below:
a. Minister: the Minister of Education, Culture and Science,
b. Committee: the committee referred to Article 2.

<u>Article 2 Establishment and task</u>
1. There is a National Roadmap Committee for Large-Scale Research Facilities.
2. The task of the Committee is to draw up a national roadmap pre-selecting and prioritising potential large-scale research facility projects in the Netherlands for purposes of scientific research. The Committee will take the following matters into account:
a. coordination with developments in Europe, in particular the development of the ESFRI roadmap, and beyond; and
b. the criteria set out in the Nijkamp Report and applied in implementing the NWO-BIG incentive programme for large-scale research facilities and the ESFRI roadmap.

<u>Article 3 Term of Committee</u>
The Committee will be inaugurated on 1 May 2007 and discontinued on 1 March 2008.

<u>Article 4 Obligation to provide Information</u>
The Committee will furnish the Minister with any information he wishes to receive at his request.

<u>Article 5 Members</u>
1. The following persons will be appointed to the Committee:
a. W.G. van Velzen, chairperson
b. Prof. W.J. van den Akker
c. Prof. J.A.M. Bleeker
d. Dr K.H. Chang
e. Prof. J.C. Clevers
f. Dr W. van Drimmelen
g. Prof. L.J. Gunning-Schepers
h. Prof. L. Hordijk
i. Prof. J. Joosten

j. P.J.J.G. Nabuurs
k. Prof. D.N. Reinhoudt
l. Prof. W. van Vierssen

2. The Committee will be assisted by a secretary and one or more experts where necessary. The secretary and any such experts will be appointed by the Minister. The secretary and experts will not be members of the Committee.
3. The term of appointment will run parallel to the term of the Committee.

Article 6 Working method

1. The Committee will determine its own working methods.
2. Where necessary to carry out its tasks, the Committee may call in other persons to assist it, including expert officials acting in a private capacity.

Article 7 Final report

The Committee will issue its final report to the Minister before the end of 2007. The report will present the Committee's recommendations for a national roadmap, accompanied by sound arguments.

Article 8 Fees

1. With the exception of the chairperson, the members of the Committee will receive a fee for each meeting (insofar as they are not public servants), based on the 1988 Attendance Fee Decree [*Vacatiegeldenbesluit* 1988] and the provisions based on this decree as applied by the Ministry of Education, Culture and Science, with the Committee being designated a general committee within the meaning of the 1988 Attendance Fee Decree. The relevant members will receive the maximum applicable fee for a general committee.
2. The Committee chairperson will receive a fixed fee pursuant to Article 3 of the 1988 Attendance Fee Decree and the provisions based on this decree as applied by the Ministry of Education, Culture and Science. The remuneration details will be specified by Royal Decree.
3. In addition to the fees referred to in Article 8(1), Committee members residing outside the Netherlands will be compensated for their travel and accommodation, based on the actual costs incurred. The Foreign Travel Decree [*Reisbesluit buitenland*] and Foreign Travel Scheme [*Reisregeling buitenland*] will be taken as guidelines in this respect.

Article 9 Committee expenses

1. The Committee's expenses will be paid by the Minister, provided they have been approved.
   Such expenses will in any event include:
   a. the cost of meetings and secretarial support;
   b. the cost of calling in external experts and contracting research; and
   c. the cost of publishing reports.
2. The Committee will submit a budget and schedule to the Minister as soon as possible after its inauguration.

Article 10 Accountability

1. The Committee will present the Minister with a final statement of accountability before the end of the year in which it describes its activities during its term of appointment. The final statement may constitute part of the Committee's final report.
2. The Committee will account for its actions in its final statement of accountability.

Article 11 Confidentiality
Insofar as they are not subject to a duty to observe confidentiality by virtue of their position, vocation or statutory rule, all persons involved in the Committee's work who have access to information that they know to be confidential or should reasonably assume to be confidential are obliged to treat such information as confidential, except insofar as they are compelled to disclose the information by any statutory rule or insofar as such disclosure is necessitated by their duties.

Article 12 Disclosure
Reports, memorandums, statements and other products produced by or on behalf of the Committee will not be disclosed by the Committee but submitted exclusively to the Minister.

Article 13 Archive documents
As soon as possible after completing its work or as much earlier as circumstances require, the Committee will transfer the documents relevant to its work to the archives of the Research and Science Policy Department of the Ministry of Education, Culture and Science.

Article 14 Effective date
1. This Resolution will become effective on the second day after the date of its publication in the Government Gazette [*Staatscourant*], with retroactive effect to 1 May 2007.
2. This Resolution will lapse on 1 March 2008.

Article 15 Reference
This Resolution will be referred to as: *Instellingsbesluit Commissie Nationale Roadmap Grootschalige Onderzoeksfaciliteiten* (Resolution inaugurating the National Roadmap Committee for Large-Scale Research Facilities).

This Resolution will be published in the Government Gazette, along with its explanatory note.

[signature]
Dr Ronald H.A. Plasterk

Explanatory note

Large-scale research facilities are of inestimable strategic significance to a dynamic Dutch knowledge economy and a flourishing innovation climate in the Netherlands. This was also the conclusion of the working group chaired by Prof. P. Nijkamp in its report [*Kennisambitie en Researchinfrastructuur van het Innovatieplatform*].[1]

In 2005, the third Balkenende Government reserved a sum of EUR 100 million for large-scale research facilities. The Netherlands Organisation for Scientific Research (NWO) subsequently set up an assessment procedure for the proposals submitted. The NWO presented its advisory report to the then Minister of Education, Culture and Science, Ms Maria van der Hoeven, on 7 December 2005 during the National Innovation Event.

The European Parliament asked the European Strategic Forum for Research Infrastructures (ESFRI) to draw up a European roadmap for large-scale research facilities. A number of countries have already drafted a national roadmap, while others are in the process of doing so. It is important to know where the Netherlands can best concentrate its efforts within the European context.

The Innovation Platform made a number of recommendations in its report, one being to draw up a Roadmap for Large-Scale Research Facilities. A national roadmap should provide strategic advice on which large-scale research facilities the Netherlands should build or participate in within an international context. The facilities concerned are so large in scale that they would exceed the budget of a single research institution; indeed, their budgets would also be considerably larger than the entire NWO budget. It should be noted that the facilities concerned cover the whole field of science and scholarship, but that those in the hard sciences are often much more expensive than database facilities in the humanities, for example. Because science is dynamic, it is important for the roadmap to be updated regularly.

<u>The Committee's working methods:</u>
The Committee will adopt a procedure at its first meeting. The procedure will mainly specify the method the Committee uses to survey possible plans for large-scale research facilities, to involve stakeholders, and to consider how to develop a roadmap.

<u>Criteria:</u>
In accordance with the recommendations issued in the Nijkamp Report, the following criteria will be applied:

1. The likelihood of scientific breakthroughs (science case)
2. The potential for 'brain gain' (talent case)
3. Collaboration and competition (partnership)
4. Social and commercial relevance (innovation case)
5. Financial aspects (business case)
6. Technical feasibility/technical challenges (technical case).

The first three criteria concern the scientific soundness of the project. The fourth criterion speaks for itself. The final two criteria are intended to assess the financial and technical feasibility ('maturity') of the project.

1 *Kennisambitie en researchinfrastructuur. Investeren in grootschalige kennisinfrastructuur*. Innovation Platform, July 2005.

Accountability:
Accountability will be provided in the form of a statement of expenses incurred, including receipts and other documents endorsed by the chairperson.

The Minister of Education, Culture and Science,

[signature]
Dr Ronald H.A. Plasterk

Appendix 3 Letter of invitation to Dutch research institutions and mailing list

VSNU Board
Attn. Research Policy Steering Committee
Postbus 13739
NL-2501 ES THE HAGUE

To the Members of the Board, 21 December 2007

The National Roadmap Commiteee for Large-Scale Research Facilities recently notified the Minister of Education, Culture and Science, Mr Plasterk, as to which of the 35 large-scale research facilities included in the European Roadmap* merit an immediate national and financial commitment. These selected and prioritised ESFRI facilities will be included in the Netherlands' first integrated Roadmap, which will be presented to the Minister before 1 June 2008.
I would like to draw your attention to two other topics discussed in the integrated Roadmap.

The first is the question of which large-scale research facilities should – from the Netherlands' vantage point – be included in the new European Roadmap that is now being developed. It is of course important to acknowledge reality (i.e. in Europe) in this regard. Second, the Roadmap will consider which large-scale research facilities the Netherlands itself should develop; such facilities should have international support, be operated under national authority, correspond with the present Government's innovation agenda and anticipate the knowledge requirements of Dutch society.

Please inform us by no later than 1 February whether there are any any large-scale research facilities that the Roadmap Committee should be aware of in view of these two topics. We would ask you to keep your responses brief at this point, limiting them to a maximum of 1 A4-format page per large-scale research facility. The Committee is particularly interested in plans or ideas that have been on the drawing board for some time, and for which the question of a 'contact point' is, in a certain sense at least, irrelevant. The Committee believes it should be possible to put together a brief description of such plans in a short period of time.

For more information, please contact Klaas Deen, Roadmap Committee secretary (T +31 (0)20 5510836, e-mail klaas.deen@bureau.knaw.nl).

Yours sincerely,
On behalf of the Roadmap Committee,
W.G. Van Velzen
Chairperson

* The Committee has followed the Innovation Platform's definition of a large-scale research facility, distinguishing between two categories:

In the first category, the hardware predominates. There is a single large device in a building or a number of interconnected devices in a highly specialised building (for example a clean room), with associated expenses for supplies and personnel. Sometimes the research focuses on a well-defined area: the best known examples are particle physics, nuclear physics and astronomy (CERN, ESO, EMBL, LOFAR). A growing number of facilities are multifunctional however. The large-scale facilities may welcome thousands of researchers a year working in a huge number of different disciplines. The second category more closely resembles the organised clustering of national, localised hardware and expertise around an international hub, leading to an international cluster of hardware and expertise that produces a new distributed facility (e.g. the Global Biodiversity Information Facility).

What is important is that both the first and the second categories involve actual facilities/tools for science, and not research programmes.

Invitation to participate in the second phase of the Roadmap Committee

Ministry of Education, Culture and Science

1. Board of the Association of Universities in the Netherlands (VSNU), Research Policy Steering Committee
2. Board of the Royal Netherlands Academy of Arts and Sciences (KNAW)
3. Board of the Netherlands Organisation for Scientific Research (NWO)
4. Board of the Netherlands Federation of University Medical Centres (NFU)
5. National Library, Dr W. van Drimmelen

Ministry of Health, Welfare and Sport

1. National Institute for Public Health and the Environment (RIVM), Dr M.J.W. Sprenger
2. Netherlands Cancer Institute, Prof. A.J.M. Berns
3. Daniel den Hoed Clinic, Prof. P.C. Levendag
4. Social and Cultural Planning Office (SCP), Prof. P. Schnabel

Ministry of Transport, Public Works and Water Management

1. Directorate-General for Water Management, Ms R. Peters
2. Royal Netherlands Meteorological Institute, Dr F.J. Brouwer

Ministry of Housing, Spatial Planning and the Environment

1. Directorate-General for the Environment, Ms S. Borgers
2. Directorate-General for Spatial Planning, C. Kuijpers
3. Spatial Planning Office, Prof. W. Derksen

Ministry of Agriculture, Nature and Food Quality

1. Directorate-General of the Ministry, Ms A. Wouters
2. Environmental Sciences Group WUR, C.T. Slingerland
3. Environment and Nature Planning Office, F. Langeweg

Ministry of Economic Affairs

1. Statistics Netherlands (CBS), G. van der Veen
2. Netherlands Bureau for Economic Policy Analysis (CPB), Prof. C. Teulings
3. Association of Large Technological Institutes (ECN, MARIN, NLR, WL/Delft Hydraulics, GeoDelft), A. Kraaijeveld
4. Netherlands Organisation for Applied Scientific Research (TNO), J.C. Huis in ‘t Veld
5. SenterNovem, W. Zwalve

Trade and industry

1. Netherlands Research Club, Prof. J.H.W. de Wit, chairperson

End notes

[1] WRR, *Innovatie vernieuwd*, June 2008
[2] Netherlands Observatory for Science and Technology (NOWT): *Wetenschaps- en Technologie-Indicatoren 2008, May 2008*. The NOWT report (table 3.11, p. 30) shows that the Netherlands scores relatively high in the rankings for the natural sciences, biomedicine and agricultural science.
[3] The fourth Balkenende Government's long-term strategy, *Naar een agenda voor duurzame productiviteits-groei* (June 2008), reports a major increase in investment in education, research and innovation, rising to an annual EUR 2.5 billion in 2011, based in part on the Innovation Platform's Knowledge Investment Agenda.
[4] Innovation Platform: *Kennisambitie & researchinfrastructuur; investeren in grootschalige kennisinfrastructuur*, June 2005, p. 27 (Nijkamp Report).
[5] These examples are taken from the Nijkamp Report.
[6] Rathenau Institute, *Grootschalige onderzoeksfaciliteiten in de Nederlandse wetenschap; een eerste aanzet tot inventarisatie en analyse*, draft, February 2008.
[7] The most important conclusions of the Rathenau Institute's study were:

- There is continuous dynamic interaction between the scientific use of the facility and the development of the technology embedded in the facility. Innovation results both from the work of scientific researchers and from the interaction between the facility and trade and industry.
- Facilities are more than technology; they are a social environment in which human capital is concentrated and social networks merge, and in which knowledge is generated and exchanged interactively. Research and innovation are social processes and a research facility is a natural concentration of people and ideas.
- Complex large-scale research facilites are environments that encourage technological innovation. Synergy emerges from the interaction between the facility and its economic and social context.
- A variety of different parties representing diverging interests are often involved in developing and using large-scale research facilities. The facility will be used by these parties for various purposes. The diversty of interests means that a facility's impact goes beyond the scientific to include social, economic and cultural effects.
- Large-scale facilities can have a strong geographical impact. They create employment and new business activity in their surroundings and generate comparative advantages for the region and country in which they are located.

[8] European Strategy Forum on Research Infrastructures, 'Eureopean Roadmap for Research Infrastructures', October 2006
[9] Science and Technology Facilities Council, *Annual Report and Accounts 2007-2008*; National Science Foundation, *Major Research Equipment and Facilities Construction*, FY 2008 NSF Budget Request to Congress.
[10] AWT Advisory Report 72, *Weloverwogen impulsen*, November 2007
[11] Examples of FES projects are the Holst Centre, the Point One Programme, the Food & Nutrition Delta Innovation Programme, the Food and Nutrition Top Institute, Genomics, the Chemicals Business Plan, the ACTS programmes and CATCHBIO.
[12] Pre-commercial Procurement COM 2007 799.
[13] The two best-known JTIs are Artemis (embedded computing systems) and ENIAC (nanotechnology used in ICT). There are also a number of other JTIs, the most relevant for the Netherlands being FCH (fuel cells and hydrogen).
[14] See COM 2007 474.
[15] For example:

- FP7, the Competitiveness and Innovation Framework Programme (CIP), and the cohesion policy instruments;
- the Structural Funds;
- the European Regional Development Fund (ERDF);
- the European Social Fund (ESF);
- the European Agricultural Fund for Rural Development (EAFRD).

[16] WRR, *Innovatie vernieuwd,* June 2008, p. 23.

[17] 'Interaction forces participants to adjust and fit their ideas into the conceptual framework of the others (generalisation). Differences become clear and lead to other choices being made from existing knowledge (differentiation). There are indications of how to fit mutual conceptual elements into new hybrids of thought and action (reciprocation), which in turn offer incentives and signposts for a new integration of shared thought and action,' WRR, p. 46/47.
[18] The European Alliance for Permanent Access encompasses key organisations active in the fields of science and scientific information, including CERN, ESA, the European Science Foundation, the Max Planck Gesellschaft, CNES, the Science and Technology Facilities Council, the British Library, the Netherlands National Library, the German National Library, the International Association of Science, Technical and Medical Publishers, JISC and a number of national coalitions for digital sustainability.
[19] See COM 2008 467.
[20] The Expert Committee's memorandum of March 2007 *'Programmeren en prioriteren van innovatief onderzoek en procedures voor indiening, beoordeling, selectie, financiering en monitoring van activiteiten en op het gebied van onderzoek en innovatie vanuit het FES* makes a number of suggestions for improving the system of incentive grants aimed at the knowledge infrastructure and the working methods used.