UTDANNINGS- OG
FORSKNINGSDEPARTEMENTET

Norwegian Ministry of Education and Research

Report No. 20 (2004–2005) to the Storting

Commitment to Research

(Chapters 1–3)

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1 Introduction and summary

Research policy reflects society's commitment to developing new knowledge. The aim of good research is to provide completely new information and to produce extended effects on both the field in question and actual practice. Inspired researchers, high expectations and appropriate research conditions are prerequisites for success. This report sets ambitious goals. The Government proposes that public funding of research be increased. If Norway is to become a leading research nation, contributions are also needed from researchers, society at large and business and industry – a joint commitment to research.

1.1 Why research?

People have constantly sought new knowledge, be it out of curiosity and wonderment, to resolve practical challenges or to question established truths. Throughout the centuries, research has been of crucial importance for the formation of society.

During the past hundred years, scientific breakthroughs such as the theory of relativity and the discovery of the DNA structure have changed our understanding of both ourselves and the world around us. Progress in several areas of research has contributed to increasing life expectancy and to raising the standard of living in almost all parts of the world. Research has also been employed negatively, for example in the development of atomic weapons and in environmentally harmful activities. But research has at the same time been necessary to shed light on such factors and to counteract them through new insight, critical thinking and improved solutions. The previous century clearly showed that research both influences and is influenced by the development of society. Many have termed the twentieth century the century of the natural sciences, and in 1999 Time Magazine elected Albert Einstein as the century's most important person.

Research has also left its mark on the development of present-day Norwegian society. The establishment of Norway's first university in 1811 was closely connected to the fight for independence, and the University of Oslo became one of the most important institutions in the development of the new Norway. At the start of the 1900s, Fridtjof Nansen's polar expedition and the 100th anniversary of Niels Henrik Abel's birth were used to give Norway substance and self-confidence as a nation of culture and knowledge. At the same time the physics professor Kristian Birkeland and the engineer Sam Eyde laid the foundation for Norsk Hydro, the enterprise that was to become one of Norway's greatest industrial adventures.

The development of research infrastructure played a key role in the reconstruction of Norway after the Second World War. In this period the foundation was also laid for considerable social science research in Norway. Since the establishment

Boks 1.1 Still only at the beginning?

In 1998 Sir John Maddox, the former editor of Nature, published the book *What remains to be discovered*. The book was a response to various claims that science had already made all the major discoveries. Based on his 25 years' experience from the journal, Maddox was of the opinion that science was still faced with a number of significant questions, for example: How did the universe come into being? How does it work? What is the origin of life? When did sexual reproduction start? What are consciousness, imagination and memory? The book shows that in spite of the great progress that has been made in the field of molecular biology, we are far from acquiring a satisfactory understanding of how DNA sequences determine an organism's qualities. Our knowledge of how consciousness functions is extremely deficient. According to Maddox, one of the most fundamental unsolved problems is the connection between Einstein's general theory of relativity and quantum mechanics – two of the twentieth century's greatest victories in the field of knowledge.

of the first institute of social science in 1950, the social sciences have left their mark on politics, public administration and social debate.

With the discovery of oil deposits in the North Sea in 1969 and the growth of the aquaculture industry from the end of the 1980s, Norway was given unique opportunities to exploit its natural advantages. In a very short time Norway has become one of the world's largest exporters of oil, gas and seafood. However, even though these industries are based on raw materials, they have always been dependent on research-based knowledge, and research will also be necessary to utilise their potential in the future.

Today, research and development are conducted on a scale that could hardly have been envisaged a few decades ago. The world's total research investments have more than doubled since 1990. A million articles are published annually in international scientific journals. Nonetheless, few will claim that the extreme limits of science have been reached: on the contrary much indicates that the opportunities and the need to develop research-based knowledge will be even greater in this new century.

In many areas scientific breakthroughs have paved the way for completely new issues and applications. For example, the survey of the human genome in 1999 constituted a significant milestone in scientific history at the same time as it offered the opportunity to study genes in a specific frame of reference and to develop totally new knowledge about the different qualities of humans and animals. Knowledge development in this area is in many ways only in an early phase.

New methods, tools and models make it possible to study phenomena that so far have been too complex to be understood in detail. For instance it is now possible to make realistic simulations of the heart's rhythm, to calculate ocean currents and to compile scenarios for economic development.

Society is in a process of constant change and requires the continuous generation of knowledge about new problems and phenomena. Twenty years ago few people believed that the central European countries would have decisive influence on the development of democracy in Europe, or that mobile telephony would acquire fundamental importance for the culture of youth. These have now become actual phenomena that require new and updated knowledge. In the same way, major changes in society can mean that specialised knowledge that was formerly regarded as marginal suddenly gains prime importance.

New insight and new progress also generate fundamental questions. Exploration of the ocean depths, space, the brain and genes' functions takes place in totally different dimensions, but they all form part of our search for insight into the origin of life. They thus give new relevance to classic philosophical questions such as: What is life? How did life start? What is the relationship between body and soul? New connections between the natural and the human sciences may well be one of the most significant features of scientific development in the twenty-first century.

Critical and informed social debate demands that important issues and conflicts be illuminated from several sources. The question of the scope and cause of climate changes, for example, demands knowledge of complex correlations in nature and in social systems and not least of connections between nature and humans. Such issues should not be subject to only one type of expertise, but should be discussed openly by several qualified players.

World society is faced by challenges that need research-based knowledge. Epidemics, natural

disasters and environmental damage are problems that in former times were regarded as decreed by fate or unsolvable but that can increasingly be predicted and counteracted by knowledge. Society's expectations of assistance from research are therefore growing.

Research is playing an increasingly important role in the ability to innovate and to create value. The main reason for the growth in the world's research activities during recent years is that business and industry is becoming more knowledge-based and finds it profitable to invest in research. For example, Finland has successfully become one of the world's most innovative nations in a relatively short time, a key factor in this development being increased research funding. Most financial studies indicate that investment in research and development yields returns in both economic and social perspectives. Many countries therefore have clear goals that involve an even greater increase in research efforts to ensure the future creation of value.

At the same time as the scope of research is being extended, information and communication technology have dramatically improved the availability of research results. In addition, there is a greater exchange of knowledge across national borders – partly due to general globalisation and partly as a result of more goal-oriented processes such as the development leading to a common European research area. This development creates new dynamics that simultaneously involve increased cooperation and more competition.

International contact has made a substantial contribution to making Norway one of the world's richest countries. It provides a unique opportunity to take part in and utilise global exchange of knowledge. But it also presupposes quality and breadth in our own research in order for us to be attractive and competitive in an international context. The Norway of the future will more than ever be dependent on solid knowledge environments. As a rich country we are also responsible for contributing to the global exchange of knowledge.

1.2 Key considerations and the way forward

This research report provides frameworks and shows the way forward for Norwegian research up to the year 2010. At the same time it paves the way for strengthening Norwegian research in the longer term. The structure of the report is based on the following key considerations:

A good starting-point: The first Bondevik government's research report from 1999 laid the foundation for a new era in Norwegian research. More than five years later it can be verified that Norwegian research is making obvious progress. Resources have increased, and there are several indications of improvements in quality. New programmes have given rise to optimism and innovation in both academic and business circles. The starting-point is good, and an appropriate basis has been created to raise Norwegian research to a leading position. One of the main points made in this report is that Norwegian research is to be strengthened but not radically changed.

Limitations: The report is intended to be comprehensive, and work on the report has provided the opportunity for input from the total range of

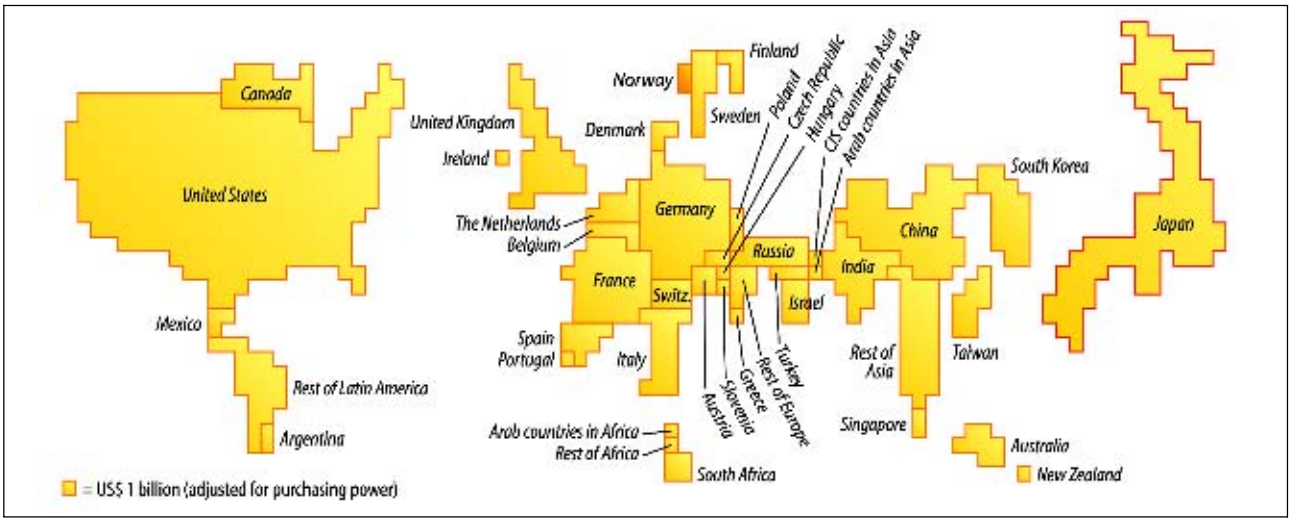


Figure 1.1 The world according to investment in research, 2000

Source: UNESCO/OECD

Norwegian research. However, it is not possible to address all themes in the framework of a report of this type. Some issues are also under evaluation or will be taken up in other documents and processes. Special emphasis has therefore been placed on issues that were not thoroughly addressed in the previous report. This applies particularly to the international perspective, research conducted in business and industry, the institute sector, and issues linked to careers in research.

Priorities: Priority will be given to research funds. But Norway is also dependent on a wide knowledge base, and future priorities will therefore mainly result from growth rather than from realigning priorities. In addition, the selected priorities will be formulated at a superior level: instead of political powers identifying specific programmes, the Government intends to define priorities more closely in dialogue with research communities, society and the private sector.

Taking internationalisation seriously: International research cooperation will be more than just words. National priorities will be considered in the context of global needs and challenges. Norwegian research must be able to offer competitive terms, and bilateral agreements will be allocated resources.

Quality: There is still a need to raise the quality of Norwegian research. This is one of the main challenges in the research policy. The report therefore focuses on quality rather than capacity building. In recent years, special measures have contributed to enhancing quality significantly. These measures will be continued, but future efforts will be more geared towards raising quality in a broad context.

Strengthening science subject research: The report paves the way for a general strengthening of research in mathematics, the natural sciences and technology. Despite an upturn in recent years, Norway has over time invested relatively too few resources in research in these areas. These are areas that are developing rapidly internationally and that often require substantial investment in equipment and in laboratories and their operation. Research-based knowledge of mathematics, the natural sciences and technology is important for the future creation of value. But these subjects do not only represent utility: they also carry the concept of culture and are vital for our ability to understand our surroundings and to take a stand on the use or misuse of this type of knowledge.

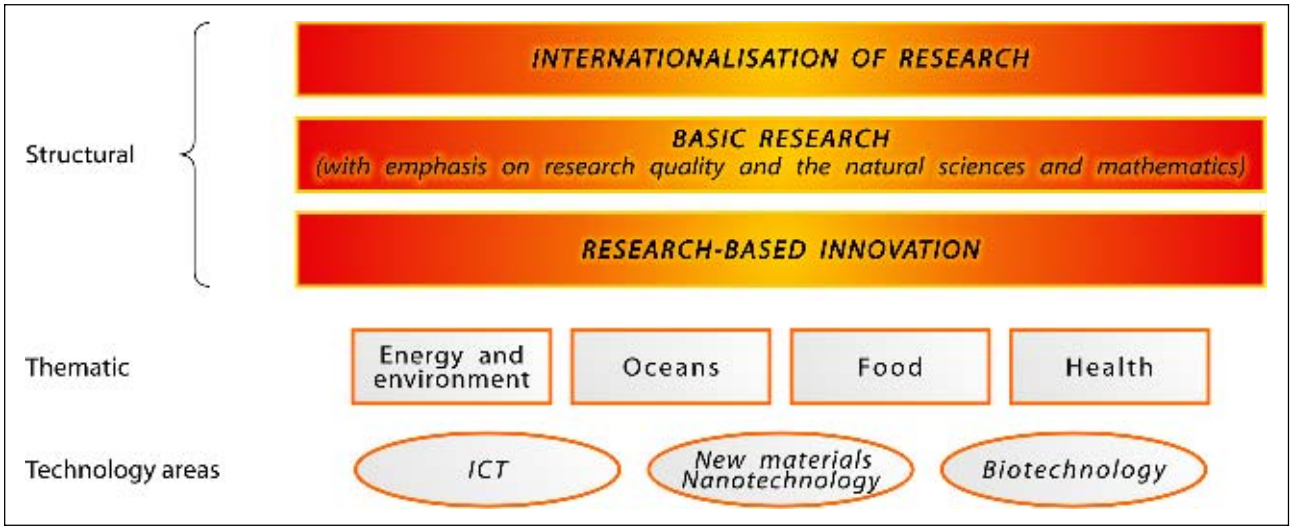
1.3 Summary

A leading research nation

The Government's goal is to ensure that Norway occupies a leading position internationally in terms of new technology, skills and knowledge[1]. Norway has one of the world's highest gross domestic products per inhabitant and the world's highest level of education – factors that provide the preconditions for becoming a leading research nation with regard to:

- Measurable research results, i.e. the number of scientific publications, citations and patents
- Success in the EU's framework programmes
- The number of researchers per 1,000 employees

[1] The Government's inaugural address, 23 October 2001.



Figur 1.2 New priorities in Norwegian research policy.

- The attractiveness of a research career for young talents
- The attractiveness of research communities for top international researchers
- The research intensity of business and industry
- Society's ability to transfer and use research-based knowledge
- The population's knowledge of research, as well as its interest in and commitment to this area.

Norwegian research performance is already good measured by several of the above indicators. However, greater efforts will be needed to maintain a leading position and to raise the level in areas where our performance is average or below average. To enable Norway to become a leading research nation, the Government aims for an increase in the total investment in research to three per cent of the GDP by 2010. Public sources will account for one per cent of the GDP. The Government proposes to increase the capital in the Research and Innovation Fund to NOK 50 billion from 1 January 2006.

When increasing funding, the Government will give priority to the following areas:

Priorities in Norwegian research policy

Three structural areas are to be given priority. Firstly, internationalisation is to constitute an overall perspective in research policy, and international participation will be emphasised when resources are channelled into research. Secondly, basic research will still be a priority area. Emphasis will be given to quality rather than capacity building. Research in the field of mathematics, science and technology will be strengthened. Thirdly, the Government will invest in research-based innovation and business development. This will provide support for the reorganisation and renewal of Norwegian business and industry and the public sector.

The Government proposes to strengthen research particularly within the thematic areas of energy and the environment, food, oceans and health. These priorities have been defined on the basis of national advantages and needs.

Information and communication technology (ICT), biotechnology, and materials and nanotechnology are three technological areas that are undergoing substantial development and that have wide areas of application. The Government will intensify its investment in these three areas. The three technology areas of priority are all relevant to the development of environmental technology.

Priorities will be made in the light of the need for increased research in and for regions with growth potential and few research activities.

If Norway is to be a leading research nation, research communities, Norwegian industry and the authorities must make united efforts. The Government is inviting those concerned to extensive and committing discussions on how goals and priorities are to be realised in the years to come.

Norwegian research at the beginning of a new era

In the previous report to the Storting (the Norwegian parliament) concerning the Government's ambitions and priorities with respect to research[2], the first Bondevik Government paved the way for the beginning of a new era in Norwegian research. The report's intention was to enhance quality, and it set ambitious goals for greater investment in research. Taking the period as a whole, the grants to research from the national budget have increased by NOK 4.6 billion, NOK 3 billion of which have been allocated during the present coalition government. This corresponds to a real growth in public funding of 27 per cent since 1999. In an international context, Norway is among the countries that have shown the greatest increase in public funding for research in recent years. In addition, the *Skattefunn* scheme was introduced from 2002 to give Norwegian enterprises tax relief for investments in research. So far it is estimated that the scheme has generated tax relief amounting to more than NOK 3.5 billion to research in Norwegian enterprises.

A large amount of the increase in public funding has been employed to strengthen basic research. Norwegian research is gradually attaining a better position internationally. For example, figures for 2002 indicate that Norway is on a level with the most advanced countries in terms of citations of scientific articles – a considerable improvement since 1991 when Norway was below the world average on this indicator.

Taking internationalisation seriously

The internationalisation of Norwegian research is assigned high priority in the Government's research policy. International research cooperation is of vital importance if the quality of Norwegian research is to be enhanced and its renewal ensured. It also allows Norwegian scientists,

[2] Report no. 39 to the Storting (1998–99) Research at the beginning of a new era.

research institutions and industry to take advantage of knowledge and technology developed abroad. In addition, international cooperation is necessary to share the risk and costs of large research investments. The Government places particular emphasis on active participation in European research cooperation, strengthening bilateral research cooperation (particularly in relation to North America and countries in Asia), and better utilisation of national assets to attract researchers and research funding from abroad. Norway also has a responsibility for contributing to the global development of knowledge, particularly in areas that benefit the least developed countries. The Government's measures to strengthen the internationalisation of Norwegian research include the following:

- The Government will initiate an extensive strategic process – involving the ministries concerned, the Research Council of Norway, Innovation Norway and other key players – with the aim of strengthening national efforts to resolve the challenges linked to research cooperation with the EU.
- Norway will participate actively in the planning of the EU's seventh framework programme for research.
- The Research Council will intensify its efforts to boost coherence between national and international activities with a view to gradually opening national programmes. All large-scale projects and programmes should be assessed and shaped in relation to international activities in the area in question.
- Active participation in European research organisations should be strengthened to enable Norway to recoup more gains from membership. The Research Council will direct its efforts to recruiting more Norwegians to the international laboratories and to encouraging Norwegian industries to take part in the competition to supply them with goods and services.
- Bilateral research cooperation will be strengthened, with special emphasis on research collaboration with North America, Japan and China.
- An overall strategy will be compiled to improve the utilisation of our national advantages in areas such as energy, environment and social science with a view to attracting more researchers and students to Norway.
- Provisions will be made to improve the funding of unique data series in areas that include environment and climate research, medicine, and social sciences – and to utilize them better in both national and international research cooperation.
- Svalbard will be further developed as an international research platform.
- The practice concerning the Directorate of Immigration's specialist quota will be assessed, and provisions will be made to enable foreign employees and Norwegian employers to better exploit such permits. A separate scheme will be set up to simplify the administrative procedures concerning family reunification for researchers who come to Norway through the specialist quota.
- The Research Council's work towards establishing a resource centre for researcher mobility (part of the European Network of Mobility Centres) will be strengthened. The centre will be adapted to the needs of researchers both within and outside Europe. Universities, university colleges and other institutions should use this centre actively when advertising vacant positions.
- Research will be more actively integrated as an instrument in international aid policy.
- More scholarships and exchange schemes will be set up for researchers and those with doctorates in order to promote mutual research cooperation as an element in both international aid policy and research policy.
- Norway's strong position in research on security, peace, conflict and development will be maintained.

Quality as a crucial factor

Quality is a crucial requirement for all research. High-quality research is instrumental in removing international research barriers. Quality is also important in facilitating access to knowledge from abroad and utilising this knowledge, as well as in attracting international researchers and research cooperation. In addition, high quality is a key element in maintaining good educational provisions and appropriate recruitment into research. Advanced professional specialisation may be necessary to develop particularly good research communities, at the same time as the research system must be wide-ranging and must ensure that it is not only the very best that become even better. Excellent conditions have been provided for communities and researchers of particularly high quality through measures such as Centres of Excellence for research and the Outstanding Young Investigators scheme. The Government will make further

investment to strengthen the quality of Norwegian research in the following areas:

- Resources for research will be increased in order to extensively strengthen basic research and provide better conditions for promising researchers. Allocation of funds to basic research will to a larger extent be based on competition.
- Research institutions will intensify their work towards higher quality. This includes follow-up of discipline-based evaluations and assessments of institutions along with strengthening professional management at all levels. Discipline-based evaluations as a form of assessment will be further developed and assigned greater importance when allocating funds.
- The Outstanding Young Investigators scheme and the Centres of Excellence (CoE) scheme will be expanded in 2006 and 2007 respectively. A new scheme will also be set up on the same pattern as the CoE scheme in the form of centres for research-based innovation.

The path towards economical, social and environmental renewal

Research and development plays a significant role for Norwegian business and industry and the public sector. The competitiveness of industry depends on the ability of the various enterprises to put to use and develop new knowledge and new technological and organisational solutions. The development of more knowledge-based trade and industry is dependent on a good infrastructure of universities, university colleges and research institutes, as well as research activity in the industry itself. High-quality research communities are also a prerequisite to encourage foreign companies to locate their research activities in Norway. Government measures to increase research investments in industry, and to generate better collaboration between the various sectors that conduct research include the following:

- Research in industry will be strengthened by increasing grants for user-initiated research through the establishment of Centres for Research-based Innovation, as well as through increased grants for industrial research and development contracts.
- Collaboration between enterprises and research institutions will be strengthened through the establishment of a scheme for industrial doctorates and through a scheme involving regional innovation centres.
- The *Skattefunn* scheme for tax relief for enterprises that carry out research will be continued.
- Efforts to commercialise research results will be reinforced by substantially increasing the grants to the Norwegian *FORNY* programme, and through a scheme providing scholarships for researchers who want to commercialise their concepts by setting up their own business.
- Measures to attract international investments in research and development will be investigated. Internationalisation activities for business and industry will be assessed with a view to strengthening Norwegian participation in the EU's technology platform initiative, boosting the participation of enterprises in the EU's framework programme for research, and increasing support to Norwegian participation in the EUREKA European network.

As research plays an important role within the public sector as a basis for policy development, management and the provision of services, Norway's long traditions of research-based management and policy development will be maintained.

- Modernisation of the public sector will be founded and reinforced through the development and use of research results. Major reforms and reorganisations will be systematically assessed, and public sector development will be founded on research-based knowledge.
- Research directed towards the renewal of the public sector will be strengthened, particularly in the areas of welfare, democracy and law, and international migration and integration.
- The scheme involving public development contracts will be consolidated.
- Databases on aspects of Norwegian society will be further developed, and the establishment of data systems that enable comparisons with other countries will be facilitated.
- Research communities and agencies will be encouraged to take an active part in the EU's work on innovation in the public sector.

Science and society

Research is an important factor in meeting the national and global challenges society faces, and it also contributes to ensuring positive changes in society and to improving quality of life. However, research can also have negative effects or can be misused. Researchers must therefore have considerable ethical awareness. Professional ethics for researchers are also decisive in ensuring good scientific practice and the quality of research results.

Since 1990 Norway has had three national ethical committees that together cover all disciplines. The Research Council of Norway will evaluate this scheme. Norway meets many of the same challenges concerning research ethics as other countries, and it is therefore appropriate that the national research ethics committees strengthen their involvement in international cooperation.

- The Government will propose to the Storting legislation on establishing a comprehensive research ethics committee system, including a system for dealing with dishonesty in research.
- The Research Council will contribute to the public research debate and will integrate the precautionary principle in the work on research programmes.
- Research institutions are responsible for ensuring that matters concerning dishonesty are handled in an appropriate and organised manner. Research institutions and the national committees will continue to provide ethical instruction for students, scholarship holders and researchers.
- A template for a standard contract will be drawn up for externally financed research. This will include a checklist that emphasises the ethical aspects of the assignment.

The dissemination of information from research environments takes place through professional cooperation or in the form of scientific publications and patenting. Conveying research information to the general public is also important in terms of raising the population's general knowledge, stimulating the desire to learn in children and young people, and paving the way for open social debate and a well-functioning democracy. The Government proposes to strengthen the dissemination of research information to the general public through the following measures:

- The funding model for universities and university colleges will be expanded to include a new result-based component for dissemination of knowledge. Indicators for the application of scientific method and research results in society at large will be central to this component. All state-funded research institutions will compile annual communication and information strategies from 2006.
- The Research Council of Norway will develop a national research and expert portal for journalists and editorial staffs. Through cooperation with several of the national education programmes for journalists, the Research Council will endeavour to increase interest in research among students, particularly in the natural sciences and technology.
- Support to science centres will be substantially increased. The Research Council and other players will cooperate in the further development and coordination of websites that convey knowledge of the natural sciences and mathematics.
- National agreements for leading professional journals for universities and university colleges will be assessed, and possible agreements will include Norway's main partner countries in development policy.

An attractive research career

Competent researchers are a basic prerequisite for a good research system and for high-quality research. The authorities are responsible for ensuring that the most talented and best-qualified candidates choose a career in research.

Major challenges related to recruitment to research appear to be threefold: increasing recruitment to mathematics, science and technology, improving the organisation of doctoral training and the career path, and making a research career more competitive.

The Government's ambitions for stepping up research investment will increase the need for recruitment of researchers, particularly within the prioritised areas of mathematics, science, technology and health. To meet the challenges outlined above, some general measures are required to improve the organisation of doctoral training and the research career path at universities and university colleges. Moreover, it will be necessary to implement specific measures targeted at disciplines with special recruitment problems. Other major themes include increasing researcher mobility, as well as gender equality in the research system. Measures are as follows:

- The number of science credits for pupils who take science subjects in secondary education will be increased. Institutions' basic funding connected to courses in mathematics, the natural sciences and technology will be strengthened.
- Special measures for recruiting medical doctors to medical research will be continued. Recruitment measures in other health-care subjects will be evaluated more closely.
- The Government will continue to increase the number of PhD fellowship positions at universities and university colleges.

- The Government will set up a scheme where graduate schools demonstrating high scientific quality can compete for status as national graduate schools with the accompanying financial support. The Government will ask the Research Council of Norway, in cooperation with the Norwegian Council for Higher Education, to prepare a proposal for this scheme.
- The Government aims to increase the number of post-doctoral positions.
- The Ministry of Education and Research will create a new teaching and research post with a duration of four to six years. The holder of the post will be assessed for fixed position as a Professor on expiry of the period.
- In strengthening the funding of Norwegian research, the Government requires that institutions employ the extra resources partly to develop an appropriate local salary policy, and partly to improve other conditions for researchers.
- The Ministry of Education and Research will investigate whether or not a statutory regulation of academic freedom at the level of the individual researcher will be beneficial to the research system.
- The Research Council of Norway will initiate a scheme for supplementary financing of Norwegian scholarship holders who travel abroad on EU scholarships.
- Schemes to facilitate the repatriation of Norwegian researchers will be assessed.
- Efforts to ensure that Norwegian researchers – particularly early stage researchers – will take research periods abroad, will be strengthened.
- Ongoing efforts to integrate the issues of gender equality at all levels in research administration, processing of applications and reporting will be maintained.
- The Research Council of Norway and the research institutions will continue their work to promote gender equality.
- The institutions must make efforts to increase the proportion of women in Adjunct Professor positions.

Research at universities, university colleges and in health enterprises

Universities and university colleges have a particular responsibility for carrying out long-term basic research and for ensuring that the Norwegian research system maintains an appropriate academic breadth. Funding for basic research will be strengthened both directly to institutions and through the Research Council of Norway. Increased resources will be divided between the institutions through competition-based schemes that take academic results and quality into account. The Government will also use the funding system to strengthen basic research in mathematics, science and technology at universities and university colleges. This will underpin the national thematic investments and will compensate for the reduction in the sector's total research activities in these disciplines in the period 1990 to 2001. Private funding of fundamental research will also be strengthened. The Government will reinforce academic quality in general, and the conditions for fundamental research in mathematics, science and technology, particularly with the following measures:

- A joint financing model for universities and colleges will substitute the existing separate models. The model includes three result-based components: education, research and dissemination of knowledge. Specific formulation of the model will be addressed in the National Budget for 2006.
- The result-based research component will include indicators for scientific publications, graduates with doctorates, and funds from the Research Council of Norway and the EU framework programmes.
- The inclusion of a result-based component for dissemination and promoting the application of research results, is especially suited for the applied research profile of state university colleges.
- Research programmes and projects geared towards state university colleges will be continued and strengthened. The programme *Strategic university college projects* will enhance the quality and scope of research activities at state university colleges, while business-oriented college programmes will enhance collaboration and mutual competence development between state university colleges and small and medium-sized companies.
- The financing model for research in the health enterprises will be assessed. Research activity in medical disciplines will be safeguarded through funding via both the university system and the regional health authorities.
- As a general rule, the Research Council will concentrate its grants on large-scale projects, while the institutions will be responsible for financing smaller projects carried out by their own employees. To encourage institutions to assign priority to operational funds for research, the Government will introduce a

scheme whereby researchers and researcher groups can apply for support for smaller funding needs related to ongoing research projects. The scheme is limited to the period 2006–2010.
- The Government will initiate a national strategy to strengthen basic research in mathematics, science and technology.
- The Government will set up a scheme where donations to research of at least NOK 5 million will be matched with a state contribution corresponding to 25 per cent of the amount of the donation. The donation must come from private persons or companies and must be given to one of the universities, the Norwegian Academy of Science and Letters, or the Research Council of Norway.
- Greater investment in research equipment will constitute an important part of the strengthening of basic research in science and technology. The current arrangement comprising funds for equipment both via the Research Council of Norway and directly to the institutions as strategic research funding will be retained. The Research Council will survey and assess national needs and, in cooperation with the institutions, develop realistic strategies for assigning investment priorities.

Research institutes

During the past 50 years Norway has built up an extensive research institute sector. The sector is intended to cover specific needs for knowledge and to promote business and regional development. The institutes' framework conditions have changed considerably in the last decade. Universities and university colleges focus more and more on commercialising research results and cooperating with business and industry, thus entering an area formerly dominated by the institute sector. Institutes must to an increasing extent compete internationally for research contracts and funding. The need for knowledge in Norwegian industry and public administration is now different from what it was when the institutes were established. Last but not least, many institutes have become independent judicial entities and are to a greater extent reliant on the project and contract market. On the background of these changes, the report presents a review of the Norwegian institute sector.

The review of research institutes has shown that the Norwegian institute sector is large when viewed in an international context, although its scope is not unique. In general, research institutes provide research and development services of high quality. They are included in networks and alliances with universities and university colleges and with companies, and there is no reason to believe that they create obstacles for cooperation between industry and the university and university college sector. Neither is there anything to indicate that industry's purchase of research services from the institutes suppresses the companies' own research. On the contrary, it appears that the two sectors' activities and competencies complement each other.

One of the Government's prime objectives is to ensure the continuation of a strong institute sector that can provide business and industry and the public sector with relevant competence and research services of a high international level. Measures to achieve this objective are as follows:
- The Government will make provisions for the further development of the cooperation between universities, university colleges and research institutes.
- The strategic role that the Research Council of Norway plays in the institute sector will be strengthened. The Research Council is assigned the task of compiling suggestions for new guidelines for government funding of research institutes, including a new financing system and allocation regime for basic grants to the institutes.
- Basic grants to the technical/industrial institutes and environmental institutes will be increased in order to strengthen long-term competence building and the institutes' international competitive ability.
- Funding of the regional institutes and the research activities of the state university colleges will be strengthened and will be formulated in a way that promotes cooperation and regional development.
- As a basis for further policy development, the Research Council of Norway will review research institutes in the fields of labour and social policies and of foreign and security policy.
- The administration of core funding for the Norwegian Institute of International Affairs and the research institute Norwegian Social Research will be transferred from the Ministry of Education and Research to the Research Council of Norway with effect from 1 January 2006.

The Research Council of Norway

The Research Council of Norway plays a key role in Norwegian research as an advisor on research policy for the authorities. The Research Council has the main responsibility for monitoring overarching priorities in research policy, and will therefore assume an important role in monitoring the priorities in this report. The Research Council has recently been reorganised, and the restructuring process has placed emphasis on the fact that the Research Council must have an open method of working and an active dialogue with research communities, business and industry, public administration and other clients. Instruments and procedures must be adapted to the various user groups. The Research Council of Norway is responsible for the entire spectrum – from basic research to innovation. This provides good opportunities for coordination and for forming connections between basic research and research-based innovation.

2 A leading research nation

The Government's goal is to ensure that Norway occupies a leading position internationally in terms of new technology, skills and knowledge. This requires Norway to have research communities that are able to keep pace with international research in most disciplines, while in some fields Norwegian research should be at the forefront and contribute to the advancement of knowledge development.

Norway has one of the world's highest gross domestic products per inhabitant and the world's highest level of education. Both financial and human resources indicate that Norway has the preconditions for becoming a leading research nation. More specifically this means that Norway should be among the leading nations with regard to:

- measurable research results, i.e. the number of scientific publications, citations and patents
- success in the EU's framework programmes
- the number of researchers per 1,000 employees
- the attractiveness of a research career for young talents
- the attractiveness of research environments for top international researchers
- the research intensity of business and industry (comparisons according to industry)
- society's ability to transfer and use research-based knowledge
- the population's knowledge of research, as well as its commitment to this area

Norwegian research is already in a good position in relation to several of the above indicators. But in many areas we are still average or below average in the OECD area. Greater investment will be necessary in order to maintain any leading position we may acquire and to raise the level in areas where our performance is average or below average. To enable Norway to become a leading research nation, the Government will

- implement measures to increase total research investment to three per cent of the GDP by 2010, one per cent of the GDP to come from public sources
- increase the capital in the Fund for Research and Innovation to NOK 50 billion from January 2006

2.1 International development trends

In pace with international knowledge expansion, investment in research and development has increased considerably in many parts of the world. The world's total research investments almost doubled in the short period 1990–2000. At the turn of the century, Europe and North America together accounted for two-thirds of the world's research resources. However, the development in the past ten years shows that several of the countries in Asia are experiencing far greater research growth than both the USA and Europe. For example, China's collective research investment has more than quadrupled since 1990, while India's research resources have increased eight-fold in the same period[1]. On the other hand, research resources in

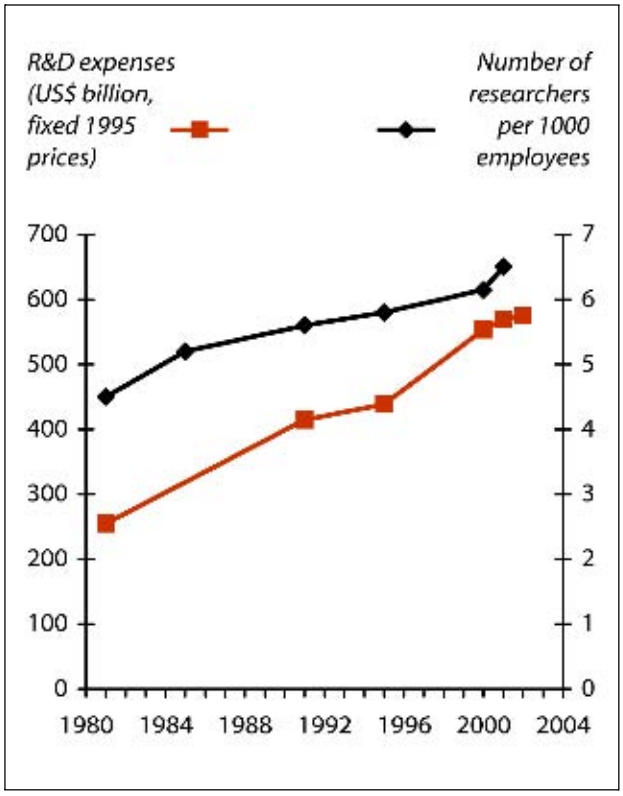


Figure 2.1 Research expenditure and number of researchers in the OECD countries, 1981–2002

Source: OECD

[1] Unesco Institute for Statistics (UIS) – 2004

the African countries have remained at almost the same level during the entire ten-year period.

A major cause of the past decade's growth in research funding is the importance of research as a competitive edge and a motive force for the creation of value. An overall international trend is that research is increasingly seen in the context of national innovation ability, and greater investment in research is regarded as necessary to ensure future growth and welfare. This is discussed in more detail in section 6.1.

In spring 2000 the EU adopted the so-called Lisbon strategy that aims to make the EU the most competitive region in the world by 2010. The strategy is based on three cornerstones: economic policy, social policy and environment policy. At the Barcelona summit meeting the year after, heads of state agreed that the EU's goal is to increase investment in research to an amount approaching three per cent of the GDP in 2010, two-thirds of which is to come from the private sector. The Commission has later emphasised the need for a greater research initiative in the member countries, most recently in connection with the EU summit meeting in spring 2005. This is discussed in more detail in section 4.3.

The EU's joint objective of higher spending on research entails high ambitions for a number of key research nations. Several of the member countries intend to increase research investment considerably in the next few years.

2.2 Norwegian research at the beginning of a new era

In the previous Report to the Storting[2], the Bondevik Government paved the way for the beginning of a new era in Norwegian research. The report's intention was to enhance quality, and its goal was to raise Norwegian research investment to the average OECD level by 2005, measured as a proportion of the GDP. The report also identified a total growth need of NOK 5 billion, NOK 2 billion of which was to come from public sources and NOK 3 billion from business and industry.

Taking the period as a whole, grants to research from the central government budget have increased by NOK 4.6 billion, NOK 3 billion of which was allocated during the coalition government. This corresponds to a growth in public funding in real terms of 27 per cent since 1999. In an international context, Norway is among the countries that have had the highest growth in public grants to research during the past five-year period (cf. figure 2.3).

The Fund for Research and Innovation has provided the foundation for much of the growth in public research funds in this period. Since the establishment of the fund in 1999, its capital has increased to NOK 36 billion. Returns from the fund have contributed to both growth and predictability in research financing.

[2] Report no. 39 to the Storting (1998–99), Research at the beginning of a new era

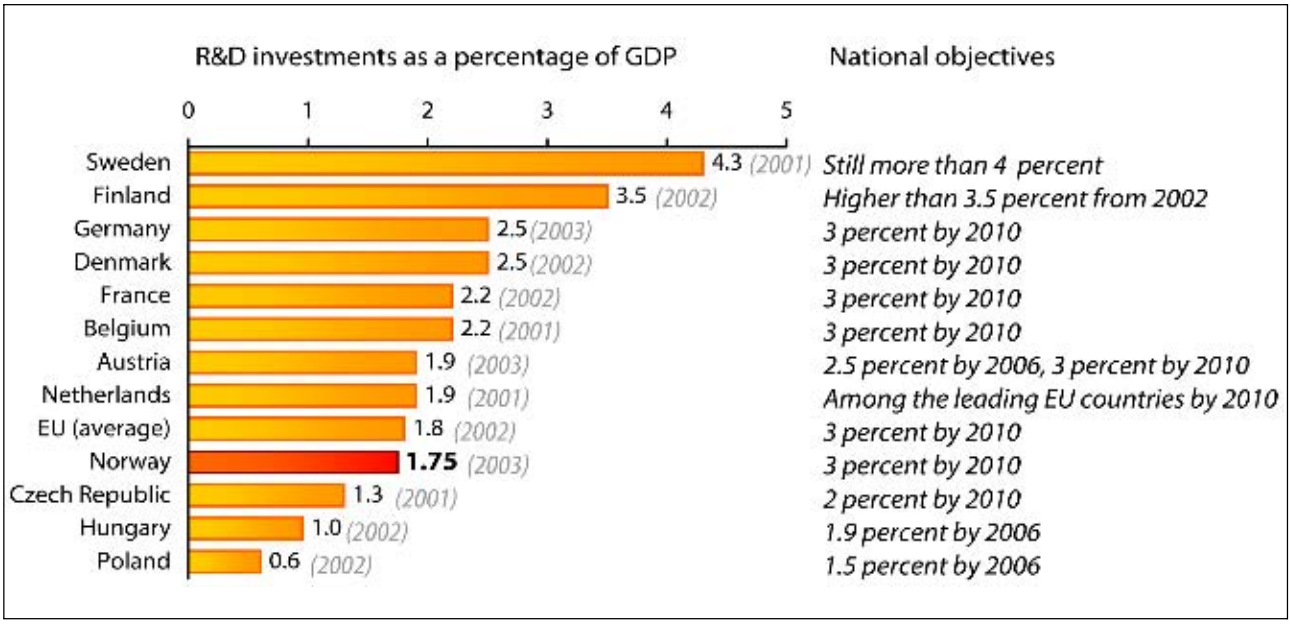


Figure 2.2 Research policy ambitions in selected countries

Source: OECD/Eurostat

An appreciable amount of the increase in public funding has been employed to strengthen basic research. This was one of the chief priorities in the previous research report. Estimates from the Research Council show that funds to basic research increased by approximately NOK 2 billion in the period 2001–2004. Around two-thirds of this growth has been channelled directly to universities and university colleges, and Norway is now one of the countries worldwide that allocates most funds per inhabitant to research in this sector. The thematic areas of priority from the previous research report have also been allocated resources, but to a somewhat lesser degree than those given to basic research (cf. below).

Efforts to enhance the quality of research have included the establishment of 13 Centres of Excellence and the introduction of a scheme for outstanding young investigators. In addition, the financing system for universities and university colleges has been changed to enable institutions to be given credit for research results to a greater extent. Several indicators show that Norwegian research is gaining a better position in an international context. For instance, figures for 2002 indicate that Norway is on a level with leading countries in terms of being quoted in scientific articles, while only ten years ago this country was below the world average in this regard.

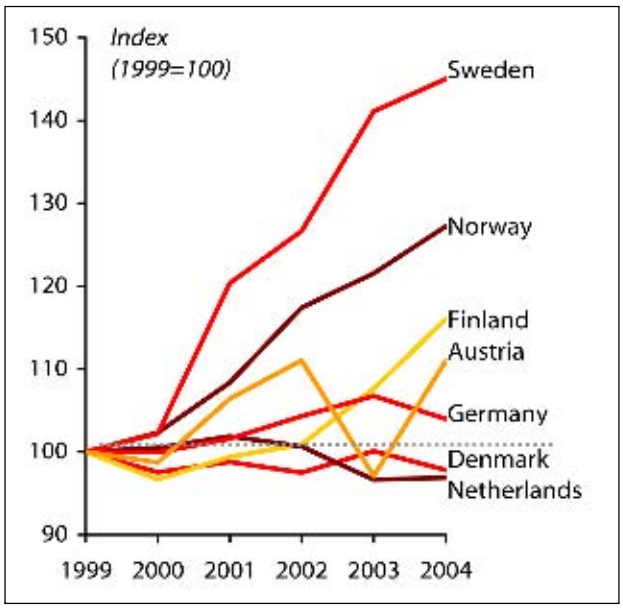


Figure 2.3 Growth in real terms in public research grants in selected European countries, 1999–2004. 100 = grant level in 1999

Source: OECD/Studies in Innovation, Research and Education (Norway)

In addition to increased public grants, schemes have been introduced that aim to promote more research in Norwegian companies and greater cooperation between companies and universities and university colleges. From 2002 a scheme came into effect that gives Norwegian enterprises tax relief on investment in research – the so-called *Skattefunn* scheme. So far it is estimated that the scheme has generated tax relief for research in Norwegian companies amounting to NOK 3.5– 4 billion, around NOK 1.8 billion of this in 2004. It is still too early to estimate the extent to which the scheme has helped to generate more research from the companies themselves, but figures from 2003 show that R&D investment from business and industry has increased by NOK 2.8 billion since 1999. At the same time, amendments were made to legislation in order to promote and make provisions for greater commercialisation of research results from universities and university colleges. From 2005, NOK 667 million has also been allocated to a nationwide seed-corn fund that is intended to contribute to public/private co-financing of innovative projects based on research.

Most indicators show that Norwegian research is becoming more and more international. For instance, almost half the Norwegian scientific publications are written in collaboration with foreign researchers, and the cooperation has been extended to cover more countries than previously. European research cooperation is in the process of becoming a significant cooperation and competition arena as well as a major financing source for Norwegian researchers. Preliminary results from the EU's sixth framework programme for research indicate that applications involving Norwegian participation have the highest rate of acceptance of all participant countries. The ceiling for public top-up funding of EU projects in the institute sector has now been increased to NOK 100 million, enabling Norwegian participation in the EU's framework programmes to be strengthened and further exploited.

On the whole, the follow-up of the previous research report has created positive development in Norwegian research and has laid an appropriate foundation for further efforts. Norway is now regarded as one of the OECD countries that have adopted important new measures in research policy during recent years[3]. Nonetheless, there are still unfulfilled needs, unsolved tasks and unexploited potential in Norwegian research communities. For example, Norway is still considerably

[3] OECD – Science, Technology and Industry Outlook 2004

below the OECD average in terms of total research investment as a proportion of the GDP. Discipline-based international evaluations have also pointed to several structural problems that have an inhibiting effect on Norwegian research. Chapter 3 provides a closer description of the status and long-term development trends in Norwegian research.

2.3 Needs and reasons for greater research investment

The prospect of more investment in research in other countries means that Norway must also increase its funding merely to maintain its current position. The Government's goal is for Norway to rise above today's level and to become a leading research nation. There are several reasons why Norway should have this ambition.

2.3.1 Research and self-understanding

Greater research investment is closely connected to the trend towards more knowledge-based societies. What partly distinguishes the current definition of a knowledge society from former concepts is the fact that many people possess appreciable knowledge, and that knowledge in many ways constitutes a central feature in all parts of society.

Research is both a prerequisite for and a result of an overall enhancement of the educational level. The principle of research-based higher education makes it necessary to strengthen research communities in line with the development of higher education. Research also has fundamental significance for our ability to identify and take a stand on new problems and phenomena. Researcher-initiated and independent research is a major precondition for open and informed social debate and for a better understanding of ourselves and our surroundings. This is often referred to as the cultural function of research and is closely linked to free and open societies. According to the scientific philosopher Karl Popper, open societies are characterised by:

- the freedom to propose solutions to society's problems and challenges
- openness to criticism, regardless of who is criticising
- the introduction of reforms based on critical and discussed proposals
- openness that allows the results of reforms to be tested

It is also easy to find corresponding features in the researcher community, and research communities that do not have these qualities will usually be in a state of stagnation or decline. Chapter 9 discusses issues related to this subject in more detail.

2.3.2 Research and challenges to society

Research-based knowledge is constantly gaining more importance for the process of resolving the challenges confronting society. To begin with, many problems are so complex and comprehensive that new knowledge is required to both understand and solve them. Secondly, there has been an increase in society's requirements and expectations that research will contribute to a better society. The challenges faced by the international community in areas such as health and the environment are examples of undertakings that will demand greater research investment, and are also areas where Norwegian research can make a contribution. The expansion of the EU to 25 member countries and the work on a common European constitutional treaty provides an example of an extensive social process that will result in major changes and challenges for many countries – both within and outside the EU.

Several development trends in Norwegian society also indicate a need for research-based knowledge. One of the main challenges of the years to come will be to ensure that society has adequate access to labour and that the workforce is developed and utilised in the best possible manner. The prospects of a general rise in the age of the population combined with high absence due to illness and a relatively small workforce reserve indicate the need for efficiency, innovation and appropriate schemes in the Norwegian working community of the future. Similarly, increased needs and expectations for welfare will demand new knowledge of the functioning and structure of the institutions and of the interaction between the public sector, the market and civil society. Knowledge of migration and integration is becoming increasingly relevant in mastering the transition to a more multicultural society with a diversity of religions. Another significant trend is the growing implementation of legal instruments in society as a result of both national and international processes. This is of crucial importance for democratic development. Research that can shed light on the scope and implications of the development is needed – research that will also promote a better understanding and handling of what is involved. A more detailed description of these issues can be found in section 6.5.

2.3.3 Research as an investment

A number of international and national studies show that investment in research and development is in general profitable from both commercial and socio-economic perspectives. But even though the private sector will make the research investments it regards as commercially profitable, it has been widely acknowledged that the sum of companies' investment in research will be lower than that regarded as economically optimal for society.

Both the OECD's growth studies and general economic growth theory define research and development as an important source of growth. In contrast to factors such as land, work and capital, research does not have diminishing marginal utility. An increase in a given level of investment can produce a temporary increase in growth rate, but higher investment in research will generate a long-term increase[4]. The OECD has estimated that a 0.1 per cent increase in R&D intensity can generate a lasting increase in growth rate per inhabitant that approaches 0.2 per cent. Such calculations will always be uncertain and can produce different results for different countries. However, most calculations point to significant additional benefits from research and development[5]. More detailed information on research and financial returns is given in section 6.2.

2.3.4 Needs and potential in Norwegian research

A number of aspects indicate that there are sufficient unfulfilled needs and access to capacity to enable future growth in research resources to be utilised:

- Several national application processes show that the number of highly qualified applicants far exceeds what available resources can accommodate. When applications were invited for the Centres of Excellence scheme, a total of 40 agencies were judged well qualified, while only 13 centres could be established. The application process for the Outstanding Young Investigators scheme resulted in a similar experience. Figures from the Research Council of Norway also show that over 50 per cent of applications for funds for non-programme projects are worth or well worth supporting, but the resources available only permit 5–10 per cent of the applications to be granted.
- The Research Council of Norway has mapped the needs for new scientific equipment in the price category NOK 1–100 million. The total need for such equipment amounts to NOK 2.6 billion. A new study made by the National Conference for Faculties of Natural Sciences shows that there is a need for particularly cost-consuming infrastructure and large equipment amounting to a total of NOK 2.9 billion. In addition the safe operation and maintenance of equipment must be ensured, data registers and time series built and updated, and other infrastructures established.
- Up to today, a large part of research growth has been allocated to boosting capacity and breadth in the research system. Future growth can be more geared towards exploiting the potential in the foundation that has been laid. One of the main points made in the Government's recruitment report was therefore that conditions for individual researchers were to be strengthened[6].
- Specific investment in research in the natural sciences and technology is required in Norway in order to meet future knowledge needs and to participate in international knowledge development in important areas. This entails an emphasis on research that will be expensive in the short term, but that over time will contribute to strengthening value creation in both business and industry and the public sector.
- Even though there is a general need to assign priority to enhancing quality rather than to building capacity, it will still be necessary to strengthen recruitment to research in the years to come – partly to accommodate the coming generation shift in Norwegian research. A stepping-up of the number of scholarship posts will be required to maintain current research activity.

2.4 A new resource goal: three per cent of the GDP by 2010

The need to contribute to and utilise other countries' research activities constitutes a major argument for allowing national research funding to con-

[4] Barro, R. J. and X. Sala-i-Martin (2004): Economic Growth, Cambridge, Massachusetts, MIT Press

[5] OECD (2003): The Sources of Economic Growth in the OECD countries, Paris

[6] Report no. 35 to the Storting (2001–2002), Om rekruttering til undervisnings- og forskerstillinger i universitets- og høyskolesektoren (Recruitment to teaching and research posts in the higher education sector)

form to the development in other countries: if other countries conduct more research, this will result in a greater volume of ideas from which Norway can potentially benefit[7]. A new resource goal for Norwegian research should therefore take international development into account.

Comparisons between different countries' investment in research usually consider research expenditure in relation to the total creation of value expressed as GDP. One major reason for this comparison is that research is regarded as an input factor in economy – in line with labour and capital. To maintain the growth rate, research investment must therefore be seen in connection with development in the total economy.

Total investment in research in the EU area is still less than two per cent of the GDP, while most of the member countries have ambitions for considerable growth in the period up to 2010 (see above). If the EU attains its joint three per cent goal, total research investment in the OECD area, the EU and the Nordic countries will be around three per cent of the GDP by 2010.

The Government proposes to raise the total R&D investment in Norway from the current 1.75 per cent to three per cent of the GDP by 2010. In keeping with the EU's objective, public funding will be increased to one per cent of the GDP, while the private sector and other sources will be responsible for providing the remaining two per cent. Based on GDP estimates for 2005 and prognoses up to 2010, this objective will entail an increase in public research grants of around NOK 5.8 billion, while the corresponding growth requirements for business and industry, international and other private sources will amount to approximately NOK 23 billion.

Norway is already a leading nation in terms of public research grants per inhabitant, lying somewhat above the OECD average measured as a proportion of the GDP. With public R&D funding of one per cent of the GDP by 2010, Norway will also be ranked high in terms of public funds as a proportion of the GDP.

Compared with other countries Norway has a high per capita gross national product – which makes a resource goal set in relation to the GDP particularly demanding. Norway's high GDP level is primarily due to great activity and growth in the mainland economy, but part of the creation of value also stems from the petroleum industry that in many ways represents an extraordinary addition to total value creation. At the same time, an assessment founded on mainland GDP would provide a basis for comparison that was too low as this figure disregards returns from the resources that are used in the oil industry, oil drilling and foreign shipping.

Norway also has a business structure that is to a relatively large extent based on raw materials and that also consists of a substantial proportion of small and medium-size enterprises. These structural features indicate that it will be demanding for Norway to attain the goal of private R&D funding of two per cent of the GDP in 2010. But the Government is of the opinion that Norwegian industry as a whole conducts too little research in relation to future challenges, and that one of the goals is to increase the proportion of research-based companies in Norwegian business and industry. Denmark and Finland are examples of countries that in just a few years have succeeded in increasing the research activities of business and industry significantly since the middle of the 1990s. Some of the growth towards the two per cent goal will also come from foreign and other private sources. The prospect of more extensive research cooperation in Europe will among other things provide a potential for more foreign funding for Norwegian research.

The Government also intends to direct a considerable amount of public funding to generating and fostering greater private activity. This will take place through the expansion and greater use of existing policy instruments, new measures such as the establishment of centres of research-driven innovation, and a general focus on research in mathematics, the natural sciences and technology as well as priorities that can promote increased value creation.

2.5 Need and basis for assigning priorities

In addition to the level of the total investment in research, the structure of the funds will have great significance for the returns from research. Many research areas are increasingly dependent on advanced and expensive equipment and a well-organised infrastructure. Even the biggest research nations must therefore assign priorities to their funding and recognise that not all areas can be provided with top research conditions. Growing internationalisation also allows a higher degree of

[7] Report no. 8 to the Storting (2004–2005), Utfordringer og valgmuligheter for norsk økonomi (Challenges and options for the Norwegian economy)

cooperation and sharing of work across country borders.

2.5.1 Need for priorities

It is particularly important for small countries like Norway to find the right balance between concentration and breadth in the structure of research funding. Sufficient breadth is required to enable Norwegian knowledge environments to understand and put to use knowledge developed outside the country. In addition, it is uncertain which knowledge areas will prove significant in the future. The risk of making the wrong choices is great if the area of priorities is too narrow. At the same time it is necessary to accentuate the areas where Norway can contribute and gain recognition internationally. This requires concentrations of resources that enable us to be relatively important in these areas or in specific niches. Moreover, conscious priorities must be made to avoid major areas not being covered in Norwegian research.

Research policy priorities are made at several levels – externally, nationally and by those engaged in research work[8]. The most specific example of external priorities is the organisation of the EU's framework programmes for research, which has major and increasing significance for research activity at national level. National priorities can roughly be divided into three main groups[9]:

- *Structural priorities* are priorities that are not geared towards specific disciplines or sectoral areas, but that assign priority according to more general and overall objectives or criteria.
- *Thematic priorities* are more directed towards chosen sectoral areas and are often based on the need and potential for creating value or resolving society's challenges in selected areas.
- *Technology areas* concern the development of new disciplines and technology – not least new combinations of technologies and disciplines – that require specific national funding both to follow scientific development in key areas and to safeguard the opportunity of utilising research in new areas of application.

[8] Nowotny, Scott and Gibbons: Re-Thinking Science: Mode 2 in Societal Context, 2002

[9] OECD: Governance of Public Research – toward better practices, 2003

Box 2.1 Priorities in research: examples from medicine

Assigning priorities to research fields and themes will traditionally be based on both the competence of research communities and the needs of society. However, allocations may well be made that are perceived by society as biased, unreasonable or unfair. For example:

- It is estimated that only ten per cent of the world's medical research is geared towards poverty illnesses, which amount to 90 per cent of the world's illness burden.
- Relatively little research is conducted on large groups of illness such as mental health and strain injuries.
- Relatively little research is carried out on issues that concern population groups such as women, the elderly and immigrants, or particularly vulnerable groups such as abusers of drugs/intoxicants.

Such distribution is due to several factors: the sum of individual decisions such as researchers' choices of research theme and specialist quality assessments can give unintentional overall effects. Lack of user groups with good purchasing power may mean that insufficient research is conducted on some illnesses. Alternative new forms of treatment can be too expensive to finance. Some medical fields may have a low academic status even though they are important for many patient groups.

In these cases the authorities are responsible for making priorities, partly through their overarching priorities and partly in the form of programmes that cover the problems society wishes to be researched. The authorities must at the same time ensure that the programmes are structured in a way that guarantees research of high quality. The Research Council's programmes on mental health, the health services and health economics, and health and society are examples of successful programmes in which good research competence has been developed in fields that are of great significance for the health requirements of the population.

2.5.2 Current priorities in Norway: development and status

The prevailing national priorities cover investment in all of the above three categories. The priorities are largely based on the areas to which importance was attached in the previous research report[10]:

- long-term basic research
- four thematic areas:
  - ICT
  - marine research
  - research in the area of intersection between energy and the environment
  - medical and health-care research
- quality should be promoted and rewarded in all areas

The original priorities have gradually been supplemented and to some extent followed up through three new national programmes:

- The national plan for functional genomics research (FUGE) was established in 2002 and currently receives an annual grant of almost NOK 150 million.
- From 2002 funds were also earmarked for a programme involving research into new materials, including nanoscience and nanotechnology.
- From 2004 funds for petroleum-oriented research were substantially strengthened, and the central government budget for 2005 includes an increase of NOK 113 million to this area.

In addition, the introduction of the scheme for tax relief on enterprises' research expenditure (*Skattefunn*) has provided a new dimension for assigning priorities to public funding for research. Total loss of revenues resulting from the scheme is estimated to amount to NOK 3.5–4 billion in the period 2002 to 2004. Chapter 6 discusses the scheme in more detail.

External input and responses received in connection with the work on this research report indicate wide support for the current priorities. Some speak for a greater specialisation in the various areas, while others would prefer to supplement the current areas with new. However, the main impression is that few of those concerned want the prevailing priorities to be radically changed.

The priorities have also been allocated resources, even though the increase has been distributed unevenly. Basic research has been a main priority in the allocation of public funding, and is estimated to have increased by around NOK 2 billion in the period 2001–2004. The figures for the distribution of the Research Council's funds in the period 1999–2004[11] show that marine research and research in the field of medicine and health have had a growth in real terms of almost 50 per cent. Research in the area of intersection between the environment and energy has shown a growth in real terms of 33 per cent, while ICT has had the most modest development with a growth in real terms of 7.5 per cent. On the other hand, ICT research has been appreciably strengthened through the tax relief scheme that has benefited many small and medium-sized companies in the ICT industry. In addition to the above are funds that come from sources other than the Research Council. It is difficult to distribute these funds as figures among the thematic areas.

2.5.3 Basis for future priorities

In its assessment of future priorities, the Government has attached particular importance to the issues described below.

Responses from research communities and considerations of the long-term aspect of research indicate that radical changes to current priorities are not recommended. The growing internationalisation of research will have real consequences for national priorities. In the first place this requires Norway to maintain a breadth of research that enables us to understand and take advantage of other nations' research in a wide range of areas. Secondly, Norway must build up its own knowledge and activity in research areas that are undergoing vigorous development internationally, even though Norway does not have the prerequisites to be a leading nation in the field in question. Third, Norway should utilise its national advantages, both to achieve a competitive edge and to ensure that Norwegian research assumes responsibility for knowledge development in areas where other countries do not have similar preconditions.

Emphasis will be placed on the need to meet social challenges and to safeguard future value creation. This means that major social challenges in areas such as health and the environment should be reflected in research policy priorities. Furthermore, research should be particularly geared towards areas where the potential for value cre-

[10] Report no. 39 to the Storting (1998–1999), Research at the beginning of a new era

[11] Figures from the Research Council's contribution to the study on following up the previous research report

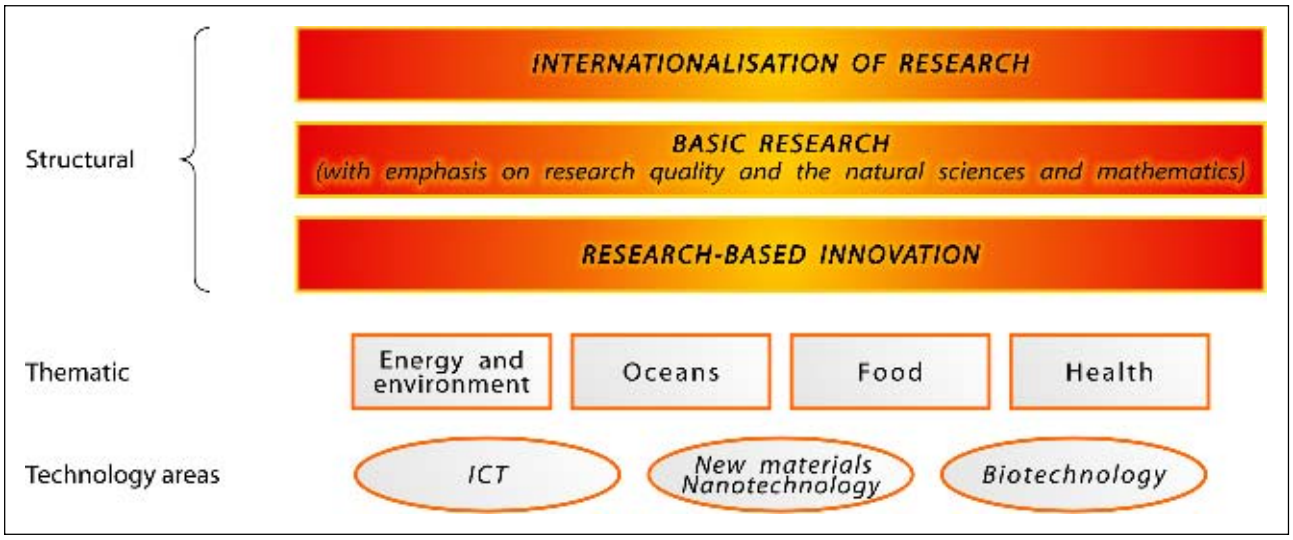


Figure 2.4 New priorities in Norwegian research policy

ation is especially large. For Norway this principally applies to exploiting natural resources. Public research funds also have an important function in relation to businesses that have a great need for knowledge but that do not themselves have the prerequisites to make adequate investment in research and development.

Priorities will also be considered in the light of the need to boost research in and for regions that show growth potential but have little research activity. Research directed towards the exploitation of natural resources and other geographical advantages will be of particular significance for the regions. The regional perspective is discussed further in sections 6.4, 9.1 and 10.3.

Priorities will primarily be realised through growth in future research funds. The current main structure of Norwegian research will be considered a starting-point for future programmes. Over time, Norwegian research has developed an extensive knowledge base in the social sciences and humanities. The social sciences in particular have experienced strong growth and have attained significant scope in Norwegian research, a position that will be maintained. However, in the coming years research must also focus on mathematics, the natural sciences and technology. In spite of positive development in recent years, the resources allocated to these disciplines have shown weak growth over time. Emphasis on research on science subjects will ensure that Norway has an academic and professional profile that is adapted to international scientific development and extensive national knowledge needs. The collective priorities must therefore be seen in the context of the need to strengthen investment in research in science (see also sections 8.1 and 9.4).

2.6 Future priorities

National priorities are intended to take into account both the breadth of and need for goal-oriented programmes in individual areas. In addition they have been compiled with the following in mind:

- utilising national advantages
- strengthening areas where there is correspondence between national and global challenges
- the need to promote more R&D in the private sector and to ensure the shift to more research-intensive and innovative business and industry
- knowledge building in areas where international science is undergoing strong development

The priorities cover an overall combination of structural priorities, thematic priorities and selected technology areas.

2.6.1 Structural priorities

Internationalisation, basic research and research-based business development and innovation will be the three structural priorities in Norwegian research. This means that emphasis will be attached to these perspectives and they will constitute key criteria for the channelling of public research funds in a wide range of disciplines.

Internationalisation

Internationalisation will be an overall perspective in research policy and will be reflected in specific priorities. Strengthening the internationalisation of Norwegian research is necessary in order to enhance the quality of research, to boost innovation in Norwegian business and industry and the public sector, and to provide Norwegian research environments with access to knowledge development in areas where we have special prerequisites. This requires Norwegian research communities to have appropriate access to international cooperation and competition arenas and to have a quality and structure that makes them attractive cooperative partners. There will be four main sub-goals in the formation of a «new-generation research policy» where internationalisation is taken seriously:

1. Active participation in the European research area
2. Strengthening bilateral research cooperation
3. Norway as an attractive host country for research
4. Norway as a global partner in research

Basic research

Basic research[12] will continue to be a main priority in research policy. Such research provides new insight, challenges established opinions, and contributes to critical and informed social debate. Moreover, basic research has great importance for society's welfare and value creation – both directly and indirectly. For instance, broad investment in basic research is fundamental to the realisation of thematic programmes in research policy. Robust basic research environments are also a prerequisite for effective and research-based higher education.

Future strengthening of basic research will focus on quality rather than capacity building. A key objective will be to secure better conditions for the best and most promising researchers. Quality enhancement will nonetheless not be limited to developing individual environments with top expertise but will also aim to foster quality on a broader basis and in all disciplines. Funds for basic research will be strengthened through direct grants to universities and university colleges and also through the Research Council of Norway. Investment in basic research will also accommodate a specific strengthening of basic research within science subjects, partly to create a better link between basic research, thematic areas of priority and research in selected technology areas. The Government will propose that a specific programme of action be compiled to strengthen basic research in science subjects. More details of this are given in section 9.4.

Research-based innovation and business development

The need for reorganising and increasing the efficiency of Norwegian business and industry and the public sector gives grounds for a general investment in research-based innovation and business development. The introduction of the *Skattefunn* scheme is a major policy instrument for increasing research and innovation in Norwegian business and industry. The scheme is to be continued and strengthened. In addition, the Government proposes to strengthen business-oriented research and other measures that can contribute to boosting research activities and the use of research in Norwegian business and industry. The utilisation of the potential in the service sector will be a key objective, particularly with regard to the use of information and communication technology. The investment will also cover research that promotes the renewal of innovation in the public sector, including welfare research, environmental protection research and research on themes such as implementing legal instruments and international migration. (See chapter 6 for more details.)

2.6.2 Thematic priorities

The Government will continue the system of thematic areas of priority and will make special provisions to strengthen research in the following four areas:

Energy and the environment

Prognoses from the International Energy Agency (IEA) show that the world's total energy requirements will increase by almost 60 per cent by 2030[13]. Fossil fuels such as coal, oil and gas will continue to be the predominant sources of energy and are estimated to amount to 85 per cent of the growth in energy consumption. At the same time, the UN climate panel has concluded that most of

[12] «Long-term basic research» is a more precise and suitable term, but due to practical considerations this report will mainly use the simpler and more general term «basic research»

[13] World Energy Outlook 2004 (IEA)

the global warming in the past 50 years can be attributed to human activity, mainly that connected to greater energy consumption and the emission of greenhouse gases. With the enactment of the Kyoto protocol, 127 countries – including Norway – have committed themselves to making a significant reduction in the emission of greenhouse gases in the period 2008–2012. One of the greatest challenges facing the international community is therefore to combine increasing energy needs with the goal of reducing emissions of greenhouse gases and other pollutants. Sustainable energy systems demand breakthroughs in knowledge and technology in many fields, indicating that research in the area of energy must be regarded as closely linked to environment research.

Many climate zones and ecological systems have their extreme limits in Norwegian areas. This means that knowledge of climate changes will be particularly important in this country. The strengthening of climate-scientific research will form a significant part of the investment in energy and the environment and will include mapping both climate changes and the environmental and social consequences.

Despite extensive recovery of petroleum resources during the past 30 years, the petroleum industry represents a large potential for future value creation. It is estimated that a total of 70 per cent of the total recoverable resources have still not been exploited. Large parts of the remaining resources on the Norwegian Continental Shelf are located in areas with demanding environmental challenges. New knowledge and technology are needed to increase the rate of recovery in general, and particularly with regard to petroleum activities in environmentally-sensitive areas. It is widely agreed – both politically and in the petroleum sector – that there is a need to strengthen collective petroleum research, and that the authorities also have a responsibility to play their part in this process. OG21, the strategy body for research and development for the petroleum industry (Oil and gas in the 21st century) and the Research Council recommend a stepping-up of public allocations to around NOK 600 million annually (see also Report no. 38 to the Storting [2003– 2004] *Oil and gas activities)*.

As a major energy nation, Norway has a significant responsibility both to ensure an adequate energy supply and to contribute to the development of knowledge and technology that facilitate efficient and sustainable energy systems. Norway has comprehensive value creation and a strong international position within oil, gas and hydropower. We are the world's third largest oil exporter, and the petroleum industry is our largest industry measured in value creation. Norway is considered to be a world leader in hydropower competence and is similarly at the forefront in terms of gas power with CO_2 handling, the use of hydrogen as an energy carrier, and in some niches in renewable energy. In addition Norway possesses vigorous research communities in the field of environment research. There are thus good grounds for Norway to become a leading nation and an attractive host country for research in the area of energy and the environment.

A joint investment in energy will unite the present funding of research at the point of intersection between energy and the environment with increased funds for petroleum – in other words efforts that will be directed to both increasing the creation of value from existing energy sources and building knowledge for the development and use of new and environmentally-friendly energy sources, as well as methods and technology that can promote a more efficient use of energy. Important areas here will be petroleum recovery, climate research, the development of sustainable energy systems, gas power with CO_2 handling, and hydrogen as a source of energy. Moreover there is a need for knowledge of energy markets, climate policy and other social aspects that affect the development and use of energy. The investment will draw on research in the technology areas of ICT and nanotechnology (see below).

Food

The world's food production must increase substantially in the coming years if it is to keep pace with anticipated population growth. In addition, a more just distribution of the world's food resources is required. One-third of all the people in Sub-Saharan Africa suffer from under-nutrition. One of the UN's millennium objectives is therefore to reduce by half the proportion of the world's population that suffers from hunger by the year 2015. Greater openness in world trade and new production and distribution methods can result in increased production and a better sharing of the world's food resources. Another challenge is to ensure that production is environmentally-friendly and ethically acceptable and that the food is safe for the consumers. Food quality and food safety are emphasised in the EU's sixth framework programme for research (*Food Quality and Safety*) that focuses on value-chain thinking and correlations between food, health and welfare.

Agriculture, fishing and aquaculture continue to be major industries in this country. International needs and development trends in the area of food therefore have great importance for Norwegian food production. Norway is one of the world's largest exporters of seafood, among other commodities. Furthermore, the food industry is the country's largest industry sector measured in number of jobs. If hotel and restaurant activities and trade in goods are included in these operations, it becomes clear that the production, distribution and sale of food represent an important part of Norwegian business and industry.

But new knowledge and new combinations of knowledge are needed to exploit the potential that lies in food production. Research has been a vital factor behind the development of the current aquaculture industry, and greater research investment will be required to continue utilising the resources in the future. Norway also has agricultural advantages that can be more fully exploited, for example with regard to research into breeding and the use of national registers for animal health.

There is a large unexploited potential for synergies between marine and land-based food production. The current thematic priorities for marine research are largely oriented towards aquaculture. A joint investment in research into food will allow a greater exploitation of synergy effects between aquaculture, agriculture and the food industry – one of the intentions of the work on the so-called blue-green food alliance (see section 10.6). In addition to research geared towards food production, investment will cover research for the processing and the sale and export of food, food safety, trade policy and international framework conditions for food production.

Sea

Research that can foster a better understanding, utilisation and management of the sea's resources attracts considerable international interest. The sea covers around 70 per cent of the earth's surface, it constitutes the core of the global ecosystems, and represents the earth's largest unresearched area. Sea level and sea currents are affected by – and are at the same time indicators of – climate changes and other weather phenomena. It is therefore of paramount importance to be able to understand and predict how sea, atmosphere, biosphere and dry land affect each other. One of the reasons this is necessary is to secure a good knowledge-based management of the coastal and ocean areas. In addition, sea areas represent a major resource for human activity in the form of fishing, aquaculture, recreation and the transport of goods and people. Furthermore, exploration of the ocean depths can provide completely new insights in the form of discoveries of new species or phenomena.

Norway has considerable advantages in this area in terms of geographical location, traditions and solid specialist environments. Norwegian coastal and sea areas contain great natural assets and thus form the basis for substantial value creation.

Greater knowledge is required of the marine ecosystems and the encroachment they can tolerate in order to ensure a sustainable management of marine resources. In addition to oil and gas and to fisheries and aquaculture, Norway possesses opportunities for appreciable value creation in the maritime industry and occupies a strong international position in this area, with maritime industries accounting for almost half of Norwegian service export. The industry is markedly knowledge-based and will require greater research initiative in several fields – from fundamental materials science to advanced services in ICT.

Investment in this area will be oriented towards the use, surveillance, management and exploration of the resources and potential of the oceans. Relevant areas will include ocean research, climate research and research geared towards the maritime sector. Funding will be relevant for the northern areas in general, and particularly for the greater exploitation of Svalbard as a research platform. Along with a number of other countries, Norway has also supported a common European investment in «Oceans» in the EU's seventh framework programme.

Health

Good health and the absence of illness are ranked highest in surveys of individual and social benefits. During the past hundred years the mortality rate has been reduced and life expectancy substantially increased in almost all parts of the world. A longer life span is a sign of a general improvement in health, a development that has to a large extent been occasioned by advancements in medical and health-care research. But high life expectancy and declining birth figures lead to a general ageing of the population and give rise to new and significant health challenges. Research is important both to procure new and better forms of treatment and to ensure that the resources in the health sector are utilised more effectively.

Most western countries are also experiencing an increase in mental problems and so-called lifestyle illnesses among both children and adults. Challenges linked to lifestyle and health make strengthening preventive measures especially necessary. Research is of significance in the areas of tobacco, alcohol, abuse of intoxicants and physical inactivity, where the potential of achieving health gains is particularly large. Global health safety will also be threatened in the future by outbreaks of known and so far unknown contagious illnesses, while increased mobility will result in such epidemics spreading more rapidly across national borders. Medical progress and greater knowledge of health issues are needed to prevent, reduce and cure illnesses and to improve the general state of health worldwide.

Norway has national advantages and excellent specialist communities in medical and health-care research. Good health registers and comprehensive population-based health surveys have placed Norway at the forefront of research into public health and cause and risk analyses. Norway also has environments that maintain a high level in the fields of medical technology, neurobiology, cancer research and preventive health, and its well-developed public health service makes it an attractive country for clinical research. In addition, Norway has a responsibility to contribute to more research geared towards illnesses that affect developing countries. The so-called 10/90 gap describes how only ten per cent of the world's resources for medical research are employed for the ninety per cent of the global illness burden that primarily affects developing countries.

National investment in health research should in the first place ensure better utilisation of national advantages in medical and health-care research, and measures will include the strengthening of infrastructure and the availability of health registers and bio-banks. The funding will also help to rectify key deficiencies and weaknesses identified in the international evaluation of Norwegian medical research – not least with regard to conditions for conducting clinical research. Clinical research competence is important to ensure a knowledge-based patient treatment of high quality. A good and efficient health service is also dependent on research in health economics and organisation. Furthermore, Norway's commitment in the field of global medical and health-care research will be strengthened substantially. The funding will also help to develop the required knowledge on minority health.

2.6.3 Technology areas

The development and use of information and communication technology (ICT), biotechnology and nanotechnology have opened up new possibilities and have left their mark on scientific development in recent decades. These three technologies are so-called generic technologies, i.e. they are assumed to have broad areas of application and considerable long-term significance for science and for the general development of society. Terms such as «future technologies» and «new sciences» are also often used, but in this case as a common designation for a number of emerging technology areas. ICT, biotechnology and nanotechnology are considered as core areas in the category of new technologies[14]. In addition to wide areas of application, these technologies are also characterised by being multidisciplinary to a high degree. For example, all the three prioritised technology areas are relevant for the development of environmental technology and for research into concepts that have significant and positive environmental impact.

In 1994 the EU Commission identified ICT and biotechnology as the two most important technologies for the years ahead. After the mapping of genes in human hereditary material, a number of countries have also established weighty programmes in biotechnological research. From the end of the 1990s nanoscience and nanotechnology have also emerged as major areas of priority in most western countries, particularly in the USA and Japan. For example, the USA's «Nanotech Initiative» from 1999 alone accounted for an investment of USD 500 million.

Norway will never be able to conduct research in these areas of the same weight and scope as the USA or Japan. Nonetheless Norwegian research must develop and maintain its own competence in order to participate in scientific development, to operate strategic technology monitoring and to secure the opportunity to utilise technologies in other specialist fields or applications. Norway also has the chance to develop internationally competitive environments in the new technologies in certain niches. Current priorities already include specific national funding for biotechnology and nanotechnology, while ICT has been an area of priority in Norwegian research policy for several years.

The Government will maintain and strengthen investment in all three areas. In the first place it is

[14] From the EU report Converging Technologies – Shaping the Future of European Societies – 2004

important to stress their generic character and their role as common scientific property. The technology areas are not intended to compete with the other priorities but to reinforce them. Secondly, development is progressing towards a higher degree of complementation and interaction between such new areas of technology. In order to exploit the synergies, the areas must be considered closely connected.

Information and communication technology (ICT)

In contrast to «newer» generic technologies, information and communication technology (ICT) has already gained noticeable importance in the development of society in general and for the daily life of the individual. Norwegian society is among the most advanced in the world in terms of the use and extensiveness of ICT solutions. ICT is also the area on which Norwegian enterprises together employ most research resources

Technology development is global, but it is the national knowledge level that is of most significance for Norwegian society's ability to benefit from the potential that lies in ICT. An international evaluation of Norwegian research into informatics has drawn the conclusion that this field has an overall high international level, but that resources are too low to allow the full potential to be exploited. A high national knowledge level requires extensive investment in research that focuses on ICT as a separate field, while also taking into account the importance of ICT as a tool for other disciplines and technology areas. The use and development of ICT will therefore be incorporated into all four of the thematic areas and will play a key role in the general investment in research-based innovation and business development.

A special investment in ICT as a technology area is necessary to ensure the knowledge development that forms the basis for the growth and use of ICT in science and in society at large. Initiatives

Box 2.2 What is the function of materials technology and nanotechnology?

Materials technology and nanotechnology – separately or together with other technologies – have several areas of application. Some examples are:

Shipping

Better understanding of the interaction between living tissue or living organisms and synthetic materials will pave the way for many interesting applications. Nanodesigned surfaces can promote or inhibit fouling by algae, bacteria and the like. This could have considerable relevance in areas as varied as the food industry and shipping. A ship's hull covered with such material will glide through the water with far less resistance than is currently the case.

Plastic packaging

Researchers worldwide are competing in the development of new biocomposites. Tiny cellulose fibres from Norwegian raw materials can give totally new properties to commodities such as plastic packaging. Cellulose is nature's polymer that helps to hold trees upright. Nanocellulose of a diameter of 10–20 nanometres can make plastic stiffer or more resistant to oxygen penetration at the same time as it can be an environmentally-friendly alternative. Other uses of nanocellulose can be to heal wounds, to control medication release in tablets, and as a natural non-animal thickening agent.

Surgery

Nanotechnology makes it possible to modify material surfaces so that they can either attract or reject certain molecules or cells. Synthetic materials and living tissue can thus be joined in new and more appropriate ways. This can form the basis of completely new transplantation technology, better implants, better surgical instruments and new medicines.

Tracing narcotics and explosives

Sensors with functionalised surfaces at nanoscale level are expected to play a key role in measuring physical, chemical and biochemical signals in a precise, rapid and cheap way. By combining nanosensors with integrated circuits, totally new sensor systems can be developed with applications ranging from environmental surveillance and tracing narcotics and explosives to medical uses such as monitoring biochemical processes and diagnostics.

for national programmes in e-science and the use of wireless technologies are examples of funding that can facilitate such strengthening of ICT as a technology area. Furthermore, research must be conducted into the use and impact of ICT, both to realise the economic potential and to reveal the social effects.

Biotechnology

Biotechnological and bioscientific research have been defined by many as the major scientific areas of the twenty-first century. The combination of fundamental biological research, new technology and new methods will extend our knowledge – for example of the origin and development of life – but will also raise new ethical issues. National knowledge development in this area will be required to enable us to participate in and take a stand on scientific development in the bioscientific area.

Biotechnological research is also gaining greater significance for areas such a food production, health, the environment and business development. Biotechnology already constitutes a sizeable industry in a number of countries and it is presumed that it will increase in importance as a growth sector internationally. In Norway biotechnological research and industrial development is a relatively young sector, but the area is growing rapidly and has great future potential. Norway has around 70–80 biotechnology companies in the fields of biomedicine, aquaculture, the marine sector, agriculture, foodstuffs and environmental surveillance. Common to most of these companies is that they are small but have a strong need for research-based knowledge. However, biotechnology can also contribute to value creation and problem-solving in areas far beyond the actual biotechnology industry itself.

National investment in functional genomics research (FUGE) has from 2001 contributed to building important technology platforms and to providing a good basis for biotechnological research. Norway also has robust basic research communities, for example the Sars Centre in Bergen that has formed a partnership with the European Molecular Biology Laboratories (EMBL). Moreover, three Centres of Excellence have been established for bioscientific disciplines.

Future investment in biotechnological research will ensure that Norway exploits its natural advantages, for instance with regard to marine resources, and will strengthen efficient and promising environments in biology and biomedicine. The national plan for functional genomics will be continued, and further initiatives will be seen in connection with the plans for a so-called FUGE II for the period 2007–2011. In addition, a reinforcement of research into ethical issues linked to biotechnology will be required.

New materials

Materials technology is often linked to so-called structural materials such as steel, aluminium, plastic, composites and concrete. These have and will continue to have a central position in wide-ranging areas of application. However, internationally we are faced with a shift in the direction of a greater use of *functional* materials: materials whose use is connected to special chemical and physical properties. In recent decades such materials have been decisive for technological breakthroughs in areas such as data technology, telecommunications, utilising renewable energy, intelligent sensors and medical equipment. Even greater expectations are linked to nanomaterials, i.e. materials that can be constructed at atom and molecule level. These will be able to supply new material combinations with completely new functions and areas of application.

If Norway is to participate in international knowledge development, a national investment in new materials and nanotechnology is required. The ongoing investment resulting from the researcher-initiated programme at the National Consortium for Research within Functional Materials and Nanotechnology (the FUNMAT programme) will be continued, partly through the Research Council's NANOMAT programme on nanotechnology and new materials.

2.7 Follow-up

The realisation of the priorities and the follow-up of the resource goal represent the Government's main strategy for raising Norway to the status of a leading research nation. The objectives will be backed by specific policy instruments and will be realised through a dialogue with research communities, business and industry and society at large.

By 2010 public research funding will amount to one per cent of the GDP, while the remaining two per cent will be provided by the private sector and other sources. Based on figures for research grants in 2005 and estimates for the development of mainland GDP up to 2010, the need for growth in public funding will be at least NOK 5.8 billion measured in fixed prices.

To ensure future growth, the Government will increase the capital in the Fund for Research and Innovation to NOK 50 billion from January 2006.

The Government has proposed research policy priorities that will be used as a basis when allocating public research funds up to the year 2010. These are overarching priorities that do not identify specific players or projects. It is important to find a balance to ensure that the different methods of assigning priorities are conducted at an appropriate level and with the correct division of work. The research communities themselves have the best prerequisites for making priorities between specific projects based on expected quality and for assessing where the scientific potential is greatest close to front-line research. At the same time, paramount priorities and total assessments of national needs and advantages should be made at political level. This includes priorities between disciplines and the choice of thematic areas.

The Government proposes that the more detailed structure of the priorities be formulated in discussions with relevant environments in Norwegian research, business and industry and society at large. The Research Council of Norway will serve as a key adviser in this area. However, in line with the reorganisation of the Research Council, other parties will also advise on the research policy and will thus contribute to the compilation of research policy priorities.

The increased yield from the Research Fund will assist in realising the main priorities. Financing from the fund ensures stable funding and provides the opportunity to plan in the long term and to realise research priorities across ministry and sector borders.

The remaining two per cent of the GDP will be funded by the private sector and other sources. This entails a total growth need of around NOK 23 billion up to the year 2010. This is an ambitious objective, and the Government will therefore also promote and pave the way for increased research funding from business and industry and from foreign and private sources:

- The overarching research policy priorities are in general directed towards strengthening business and industry's own research.
- The tax relief scheme will be continued. The scheme provides a large state contribution to research in business and industry – in addition to ordinary allocations.
- The Government also proposes to strengthen business-oriented research and other measures that can promote greater research initiatives and the use of research in Norwegian business and industry. This is discussed in more detail in chapter 6.
- Through systematic efforts towards internationalisation of Norwegian research, the state will contribute to increasing the proportion of foreign funding for Norwegian research (see also chapter 4).
- A new scheme of public co-financing will help to increase the private funding of basic research. The state will contribute 25 per cent of large private donations made to research. More details of this are given in section 9.5.

In addition to a closer dialogue with research communities, business and industry and society at large, Norway will benefit from and contribute to the EU's strategies to achieve the three per cent goal. The European research cooperation includes a so-called «Open Method of Coordination» that paves the way for systematic cooperation and exchange of experience concerning national goals and strategies in research policy.

Norwegian authorities are dependent on a high-quality and comprehensive knowledge base to enable them to formulate a good research policy and to put in place the instruments required to attain the overarching research policy goals. The Government therefore proposes to strengthen the knowledge base for the research policy.

Comprehensive work on statistics and analyses is taking place nationally – and not least through international research organisations such as the EU, OECD and the Nordic Council of Ministers. This provides access to comparative data as well as the opportunity to learn from others. Norway will make proactive efforts to utilise the possibilities provided by international cooperation in the development of a good national policy.

3 The research situation in Norway

This chapter provides a comparative overview of the Norwegian research system: the scope of research activity, those who conduct research, the research fields involved and the results that have been achieved. Information on the development of Norwegian research since the previous research report was presented in 1999 can be found in section 2.2.

3.1 R&D activity in Norway

3.1.1 Sectors engaged in research

Norway has a well-developed infrastructure for research and knowledge building in the form of universities, university colleges, research institutes, business and industry, and health enterprises.

In Norway the three sectors engaged in research have traditionally been characterised by a concentration of certain types of knowledge production: basic research at universities and to some extent at university colleges, and applied research at institutes and in business and industry. However, the roles of universities, research institutes and business and industry regarding knowledge production are now less clearly separated than previously, and there is a higher degree of cooperation across sectors. This cooperation is important for exploiting the potential of the research communities as in many disciplines the lines of demarcation between basic research and applied research are no longer so apparent. At the same time it is important for the various types of institution to retain their own particular character – for instance that the universities keep their non-commercial orientation – as the differences enhance the value of cooperation.

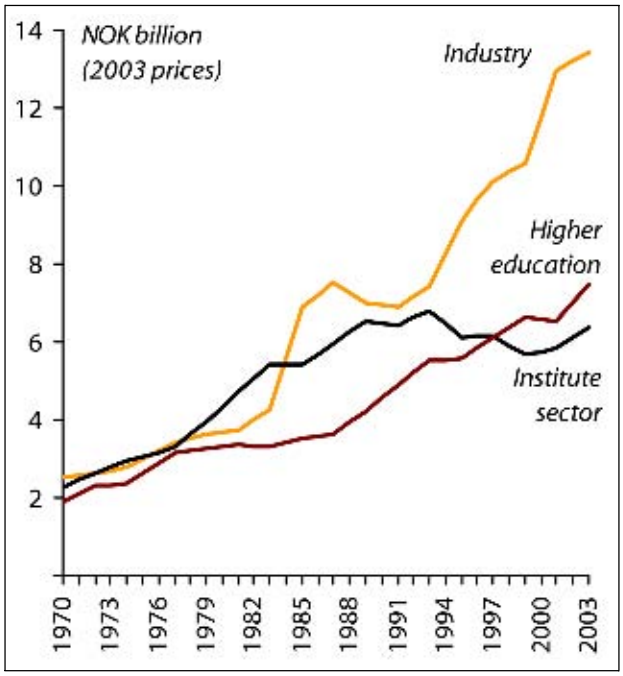


Figure 3.1 Total R&D expenditure according to research sector, 1970–2003, NOK billion measured in fixed 2003 prices

Source: Statistics Norway/Studies in Innovation, Research and Education

The higher education sector was responsible for 27 per cent of the research in Norway in 2003 (measured as expenditure on R&D), corresponding to NOK 7.5 billion. Research in this sector has increased substantially since the end of the 1980s (figure 3.1) due to the great expansion within higher education during this period and to conscious investment in recent years in long-term basic research. The branches of science are rooted in this sector, and universities and specialised university institutions have a specific national responsibility for basic research and for training researchers. It is also these institutions that conduct most of the research activity in the higher education sector (almost 90 per cent). As in most other western countries, the principle of research-based teaching has been an essential factor in the organisation of higher education in Norway. In recent years the higher education sector has been subject to considerable reorganisation (see section 9.1 for more details).

The structure of Norwegian universities and university colleges has been decentralised and was reorganised through a merger of several smaller institutions in 1994. The development of the higher education sector has ensured geographical breadth in the educational provisions and has established both large and small research communities throughout the country. The policy is also

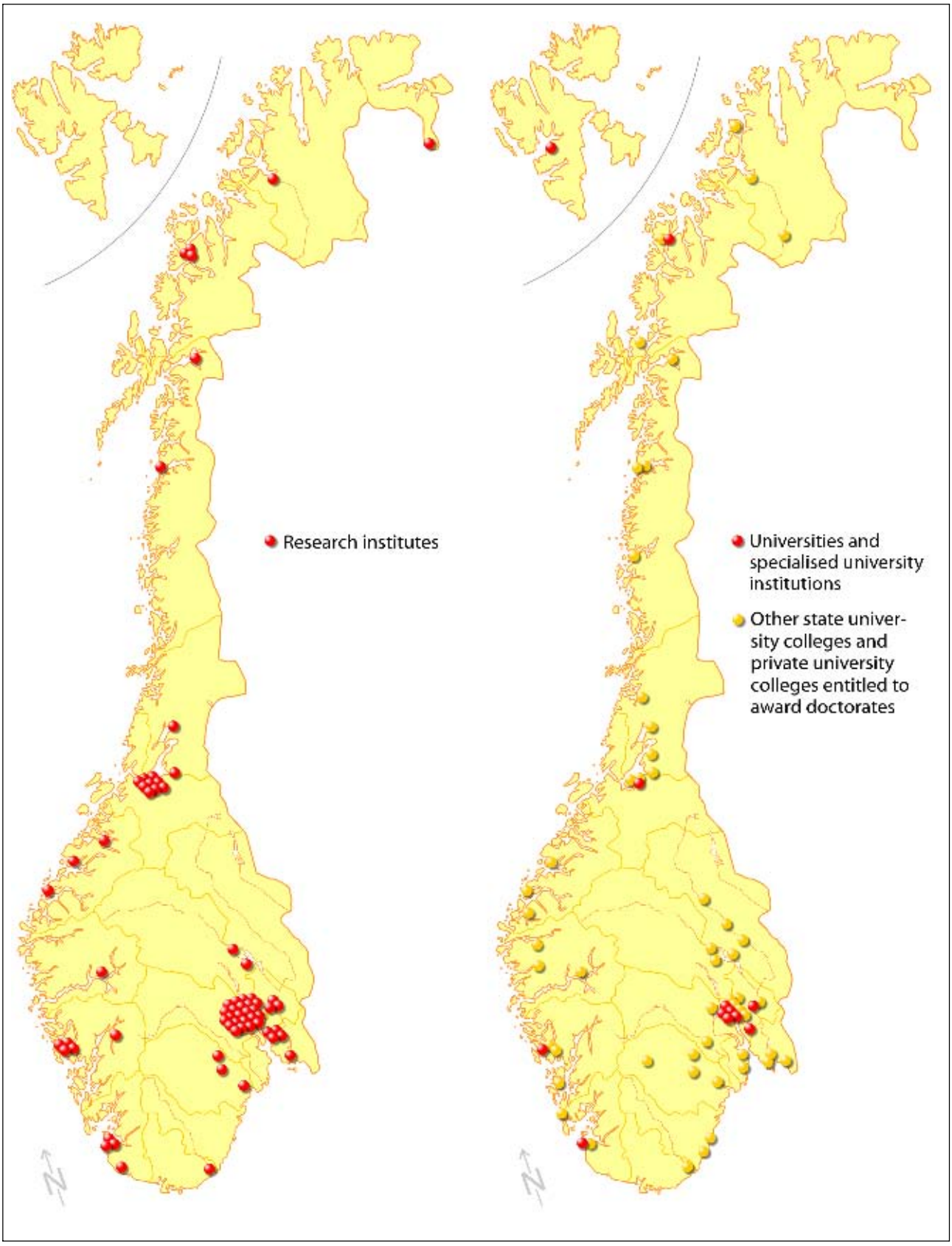


Figure 3.2 Geographical distribution of Norwegian research institutes (including sub-departments), universities and university colleges

intended to promote top professional expertise centred in the very best of the research environments.

Since their formation, the state university colleges have gradually been further expanded. The number of students has risen steeply, and the research activity has been significantly strengthened during the last two decades. The university colleges have also in the past few years been given proportionally more new scholarship posts than the universities measured in relation to their volume of research.

The institute sector consists of an extremely heterogeneous group of institutions that are engaged in research. Together these conduct 23 per cent of the total R&D in Norway, corresponding to NOK 6.3 billion. The institute sector has not increased in scope since the end of the 1980s and therefore carries out an increasingly smaller proportion of the total R&D activity in Norway. Enterprises that are covered by this term include pure research institutes, bodies that do not have R&D as their main object but that still carry out considerable R&D, and agencies in which R&D constitutes a smaller part of their activity – for example hospitals other than university hospitals and museums. The institutes serve public administration, business and industry and other customer groups. The institutes' research fields vary greatly, which reflects the diverse customer portfolio. More details of the institute sector are given in chapter 10.

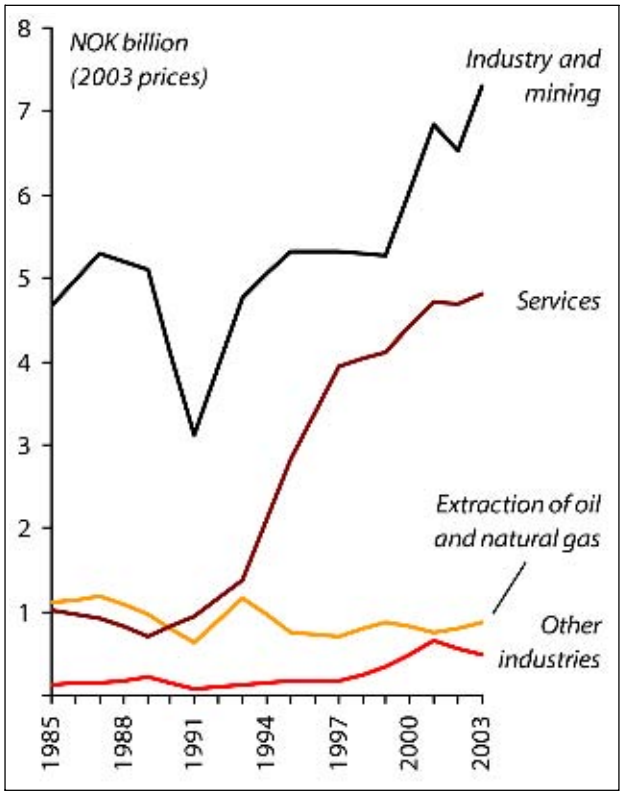


Figure 3.3 Own R&D expenditure in business and industry according to business, 1985–2003, fixed 2003 prices

Source: Statistics Norway

Business and industry is the largest sector engaged in R&D and there has been considerable growth in these activities since 1990 as knowledge has become increasingly important as a competitive factor. In 2003 business and industry conducted nearly half of all R&D in Norway, corresponding to NOK 13.4 billion, and in the same year industry was responsible for over half of this sector's total R&D (see figure 3.3). In an international context Norwegian business and industry nonetheless has a relatively low research intensity. One out of five companies in business and industry is involved in research or development work, the largest R&D investments being made in big enterprises. This particularly applies to industry, where companies with more than 200 employees are responsible for 61 per cent of the R&D investment. However, since the middle of the 1990s an increase in the proportion of R&D activity in service businesses and in small and medium-sized companies has been observed (the big change from 1993 to 1995 is mainly due to an expansion of the statistical base in 1995). In 1970 almost all business and industry's R&D took place within industry, while industry is now responsible for somewhat over half. Since 1995 the oil sector has shown a small decline in R&D activity, and industry has had a far weaker R&D growth (under 30 per cent) than the service sector (almost 70 per cent). Substantial investment in R&D has been made in the field of aquaculture.

Around five per cent of the research (R&D expenditure) in Norway in 2001 was conducted by research communities and business and industry in northern Norway. Almost ten per cent of government-funded research was performed there, which corresponds to this part of the country's proportion of the Norwegian population. Business and industry in northern Norway conducts little R&D. Such activity has shown good growth in recent years and all the three most northerly counties have received an increase in R&D funds that is higher than the average growth for the country as a whole. The University of Tromsø and the state university colleges in this part of the country play an important role in building and further developing a breadth of knowledge and regional competence.

3.1.2 Researchers

Around 50,000 persons in Norway work in R&D (figure 3.4), either as researchers or as technical or administrative support personnel. In 2003 they together accounted for more than 28,000 man-labour years in research and development work, which represents 1,400 more than in 2001. Norway has a somewhat larger proportion of its workforce employed in R&D activity than is the average in the EU, but a lower proportion than in the other Nordic countries.

Of the R&D personnel, around 35,000 are scientific staff while 15,000 provide technical and administrative support. Compared with Europe, Norwegian research stands out by the fact that technical and administrative personnel constitute a low proportion of R&D man-labour years.

Almost one in four of the R&D employees in Norway has been awarded a doctoral degree or is studying for one, and most of them work at universities. Scientific staff at universities and university colleges play a key role in ensuring quality throughout the R&D system through their special responsibility for basic research and for training competent graduates – including for business and industry and the institute sector. A career in academic circles must therefore appear attractive to the most talented graduates. The biggest challenges in this area are discussed in chapter 8.

The high number of R&D personnel in the institute sector and in business and industry constitutes a driving force for innovation and business development. The private sector has traditionally recruited few people with doctorates, but the demand for top expertise in the form of this qualification is on the increase. This is due to the fact that the supply has improved, and also that the companies in question are gradually gaining good experience of this type of competence[1].

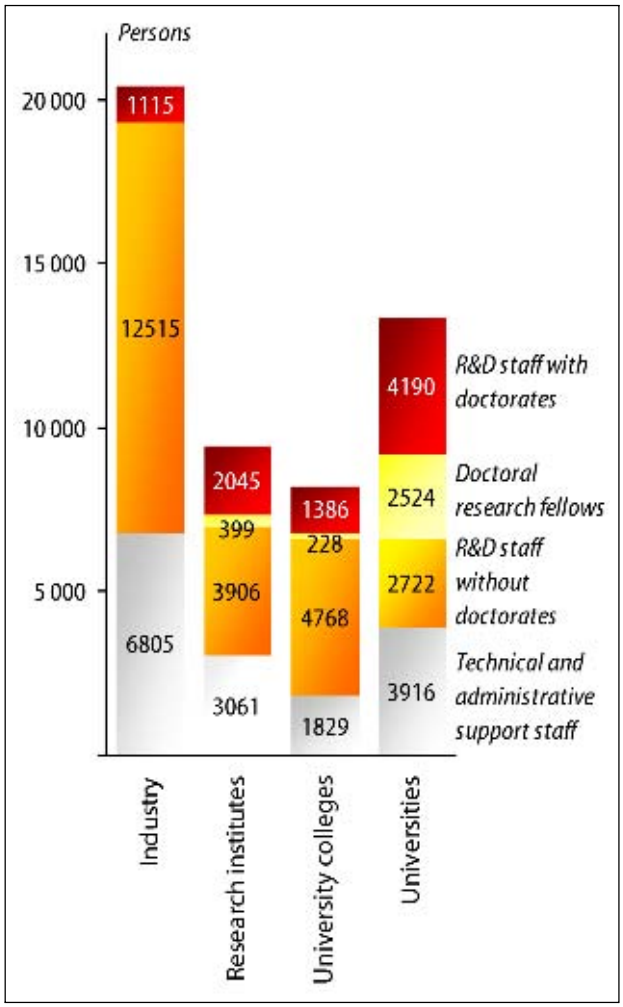


Figure 3.4 Norwegian R&D staff according to research sector, 2003

Source: Studies on Innovation, Research and Education/Statistics Norway

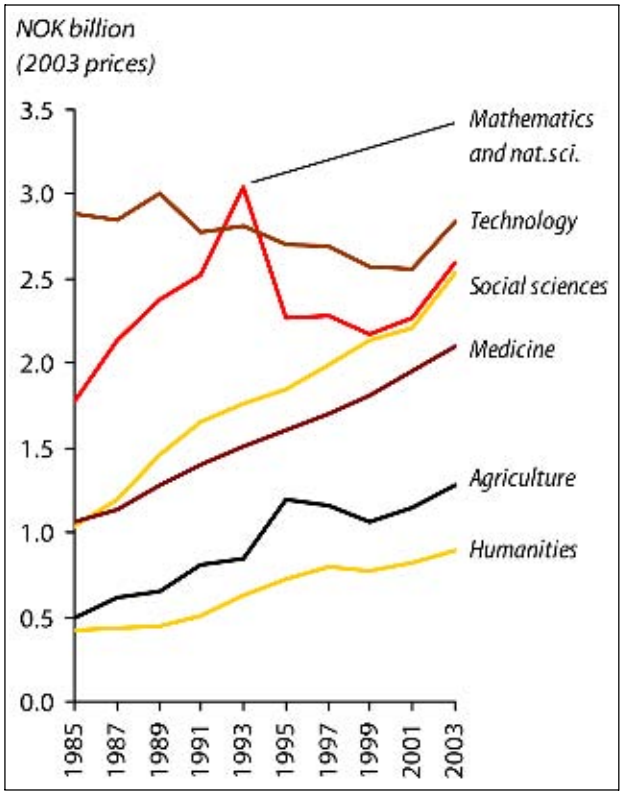


Figure 3.5 Operational expenses for research and development according to subject in the higher education and institute sectors, 1985–2003, fixed 2001 prices

Due to changes in the discipline classification between the natural sciences, technology and agricultural subjects, the figures for 1995 are not fully comparable with those of previous years.
Source: Studies on Innovation, Research and Education

3.2 Research fields

The past two decades have seen a relatively large change in the academic and professional profile of the research conducted in the higher education and institute sectors (figure 3.5). There has been a long trend of strong growth in research activity within the social sciences and medicine in the higher education sector, while research activity in technology subjects in the institute sector has been reduced and the scope of research into mathematics and the natural sciences at universities and university colleges has remained unchanged. The strong growth in research investment from 2001 to 2003 has generated growth in all disciplines and has halted the negative trend that has taken place in the science subjects since early in the 1990s.

The development in specialisation in research fields can to some extent be attributed to the authorities' research priorities, such as the focus on medical research during the past 20 years. The growth in social sciences research from the end of the eighties is partly a result of an increase in the authorities' demand for externally-financed research as a basis for formulating policy, but is more due to the development of the educational options in the social sciences in higher education. Expansion within the education system has indirectly left much of society's research priorities to the students' choice of studies, and research activity has largely followed student figures due to the way the principle of research-based teaching has been practised. This has led to a growth of research in popular subjects.

The extent of research in mathematics, science and technology stagnated in the 1990s – partly as a result of weak recruitment of students to these areas of study in higher education (see above). In addition, this period has seen poor investment in business-oriented research, and spending on laboratories, buildings etc. has not kept pace with the rising costs of experimental research.

The development of the science subjects in Norway has been regrettable both with regard to the importance of basic research in these subjects for the country's long-term innovation ability and to fostering research in business and industry, especially when the investment that has been made in other countries during the same period is taken into account. Figure 3.6 shows that the other Nordic countries doubled the number of doctoral degrees awarded in mathematics and the natural sciences in 2002 compared with 1990, while the increase in Norway has been 50 per cent. In the

[1] Gulbrandsen, M. and Larsen, I.M. (2000): Forholdet mellom næringslivet og UoH-sektoren – et krevende mangfold (The relationship between business and industry and the higher education sector – a demanding diversity). Norwegian Institute for Studies in Research and Higher Education, Report 7/2000

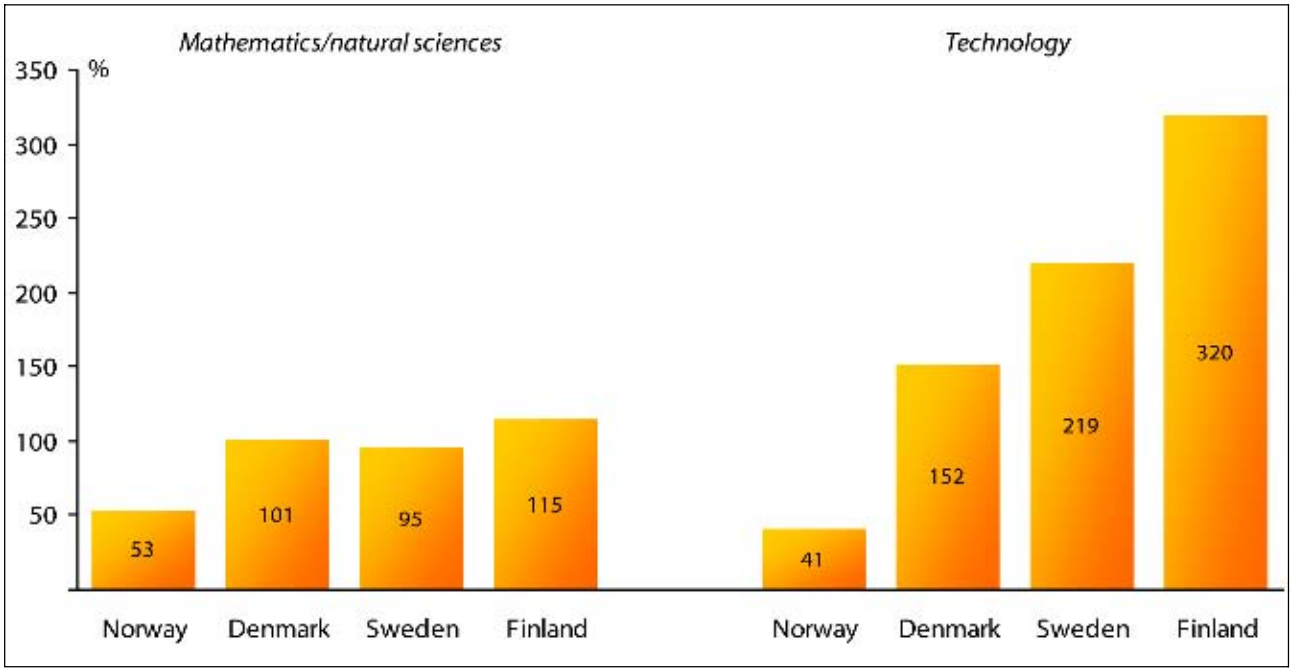


Figure 3.6 Percentage increase in the number of doctorates awarded in mathematics/natural sciences and technology subjects, 1990–2002, Norway, Denmark, Sweden and Finland

Source: Studies in Innovation, Research and Education/Statistics on awarded doctoral degrees and doctoral students in the Nordic and Baltic countries

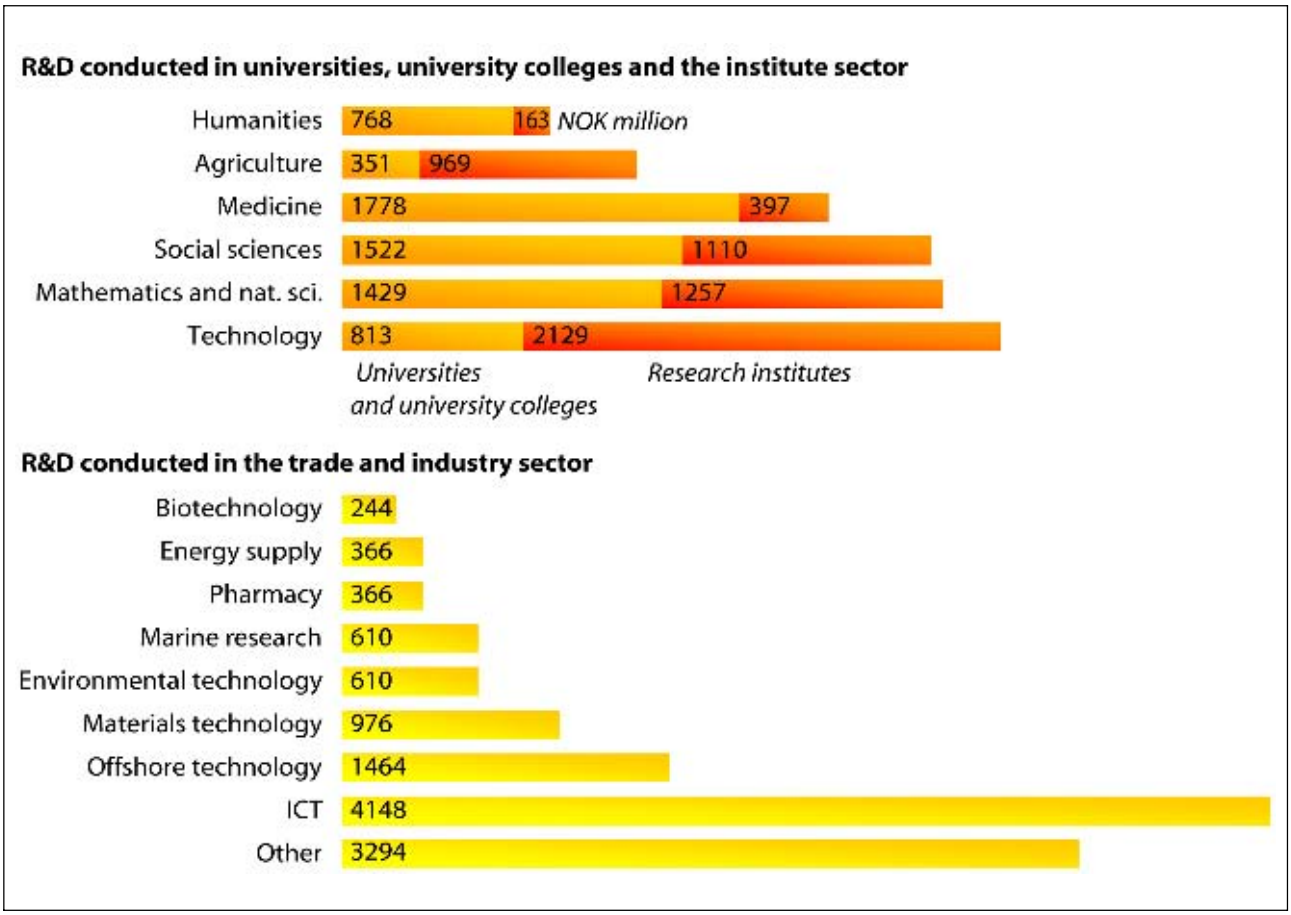


Figure 3.7 Expenditure on research and development in the higher education sector, the institute sector and business and industry, 2003, NOK million

Source: Statistics Norway/Studies in Innovation, Research and Education

technology subjects the growth in Norway (40 per cent) lies even further behind that of the other Nordic countries (320 per cent in Finland).

Despite the fact that the technology subjects' proportion of total R&D activity at universities and university colleges and in the institute sector has declined from 44 per cent in 1970 to 23 per cent in 2003, technology is still the largest research field (figure 3.7). Technology research takes place mainly in the institute sector, and in the higher education sector it is a small subject – equal in size to the humanities. In the higher education sector – which includes the university hospitals – medicine is the largest research field, followed by the social sciences and mathematics/natural science subjects. Chapters 9 and 10 give more details of research in the higher education and institute sectors.

Research and development conducted in business and industry is not divided into traditional disciplines as it is in the other research sectors above, but figure 3.7 shows that technology constitutes the largest research area in business and industry and that information and communication technology is the dominating field.

3.3 Results of R&D

It is not possible to present a complete picture of research results. The actual acknowledged consequences of research on the individual's quality of life and for the development of society cannot be quantified effectively. In many cases attempts to measure the effects of research through quantitative «external» indicators will not only be meaningless but also potentially harmful. Moreover, the results of research are in many cases applied and utilised over considerable time – often long after the research was conducted. However, it is clear that if research efforts in Norway are to lead to new understanding or the development of useful knowledge, a prerequisite is that the research is performed by competent researchers, within robust

environments, and is of a high professional standard. In recent years, many Norwegian research communities have been the object of evaluations, and these represent a significant source of information for assessing the results of research activity. Chapter 5 gives an overview of the results of these evaluations along with the challenges they have highlighted. Information on the commercial success of some instruments in business research is also available and reveals some details about the economic gains (see chapter 6). Knowledge of the socio-economic yield of research is discussed in chapter 2 and chapter 6. The extent to which Norwegian research communities are successful in international competition arenas also provides a major indication of the quality of Norwegian research, cf. subsection 4.3.1.

Two indicators that are widely used for research results are publications and patenting. Publication and citation data (bibliometric data) demonstrate the scope and quality of research results. Evaluations among researchers themselves constitute the research world's own system of quality control. Research that is published in scientific journals has undergone an inspection of its scientific quality and its importance, originality and validity. The frequency with which an article is quoted in other scientific publications is also a measurement of how great an influence it has on the development of front-line research.

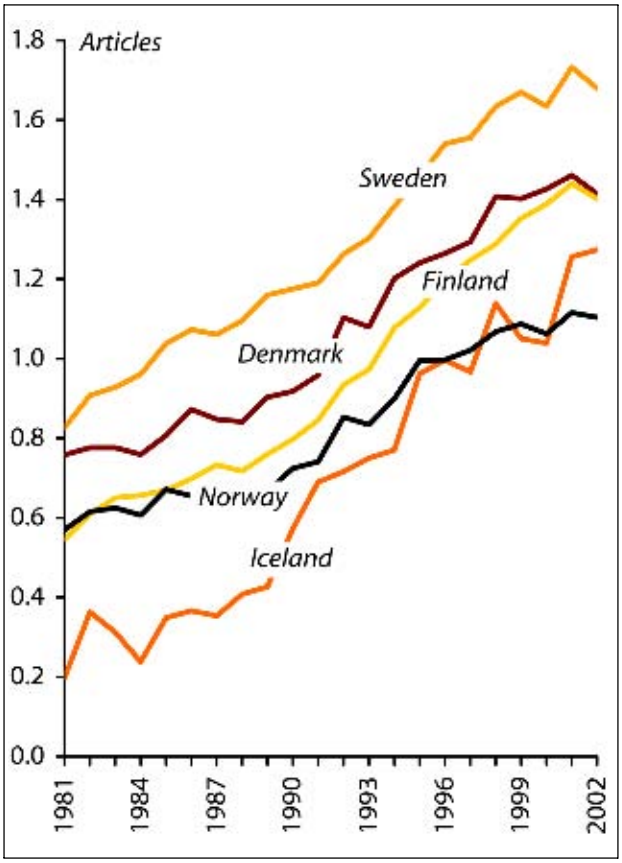


Figure 3.8 Number of scientific articles per 1,000 inhabitants in the Nordic countries, 1981–2002

Source: ISI databases/Studies in Innovation, Research and Education

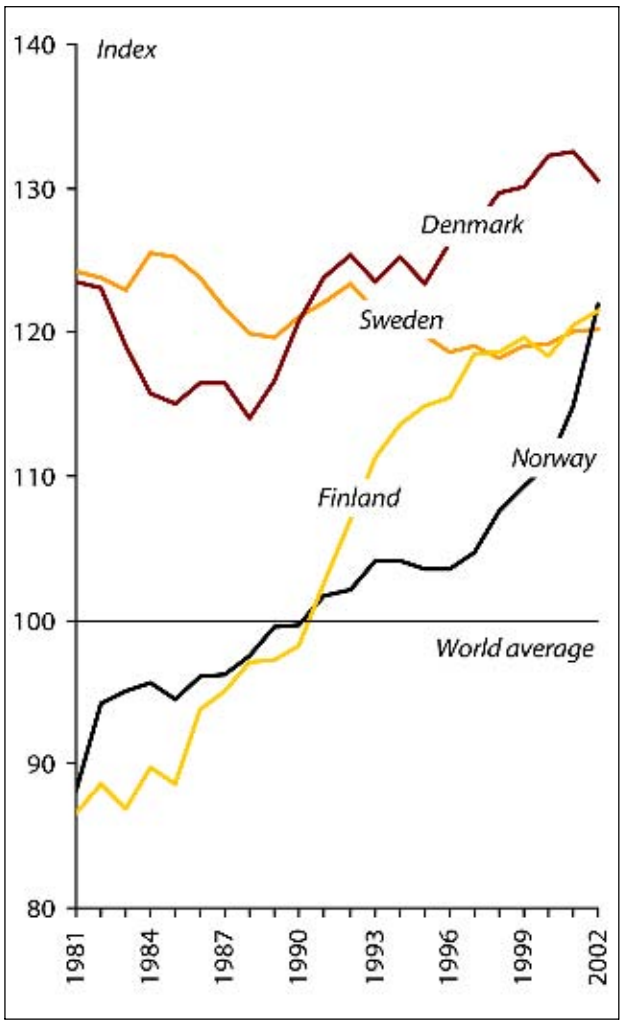


Figure 3.9 Development in the relative citation index for research in the four Nordic countries measured in relation to world average, 1981–2002, three-year sliding average

Source: ISI databases/Studies in Innovation, Research and Education

The fact that the number of scientific articles published per year by Norwegian researchers has doubled since 1980 is clearly connected to the growth in research activity in this period. However, it also shows that there has been a considerable increase in the results of this activity. The universities together were responsible for 63 per cent of the articles in 2003. The increase has been particularly obvious in the 2000s, and from 2002 to 2003 alone the number of publications rose by almost

900, from 4,400 to 5,300.[2] Measured in the number of articles produced per 1,000 inhabitants, Norway is ranked higher than countries such as the USA, Germany and Japan, but its position is not as strong as those of the other Nordic countries (figure 3.8).

Citation indicators for articles produced by Norwegian researchers have been lower than those of our neighbouring Nordic countries but have shown a very positive development in recent years (figure 3.9) with the reservation that the figures for 2002 are provisional. The number of quotations of Norwegian publications compared to the world average in the subject field is particularly high in agricultural science, engineering subjects, informatics, geo-subjects, clinical medicine, physics and mathematics.

The patenting of inventions is a significant result of research and development activities, in line with scientific publications. Patents are mainly used to publicise and protect the exclusive right to product and process innovations. Patent data can be used as an indicator of the level of activity and quality, particularly in technological R&D. However, patent data does not fully express the scope and results of R&D activity. Not all products lend themselves to patenting, not all researchers are interested in taking out patents on their findings, and patenting is not always the best method of protecting a company's economic interests.

The USA, Japan and the EU are currently the three large centres for patenting. Norway is situated somewhat on the edge of the international network with the exception of some research fields such as technologies related to oil recovery. Relatively few patent applications are submitted in Norway compared with internationally, and the number of patent applications in relation to the number of inhabitants is lower in Norway than in all the three other Nordic countries.

However, a study from the Norwegian institute Studies in Innovation, Research and Education[3] shows that a growing number of Norwegian individuals and enterprises take out patents in other countries, and that international cooperation is increasingly becoming a feature of patenting. The number of cooperative patents and patent applications registered in the USA with at least one Norwegian inventor rose by a total of 269 per cent from 1996/1997 to 2001/2002. The USA is the most important international cooperative partner for Norway, followed by Sweden, the UK and Germany.

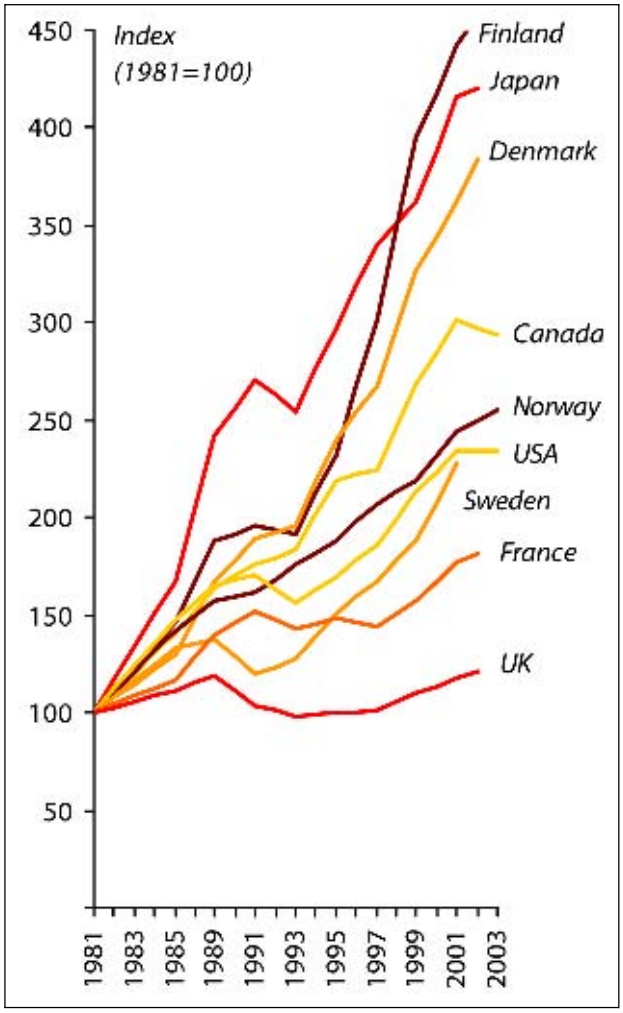


Figure 3.10 Increase in total R&D expenditure in fixed prices for selected OECD countries, 1981–2003, 1981 = 100

Source: Norwegian Institute for Studies in Research and Higher Education/OECD

The most significant player for patenting in the USA is the international group that has been known by different names – from Nycomed, via Amersham Health to today's GE Healthcare. Other important Norwegian companies are Statoil, Norsk Hydro, Thin Film Electronics ASA and the Nordic group Borealis AS. Of the American companies that have registered patents with Norwegian inventors, most are engaged in oil recovery.

Traditionally it is the research conducted in the business and industry sector that has led to patents. A study of the commercialisation of Norwegian university research nonetheless indicates that a cultural change has taken place at the universities in recent years. The attitude towards commer-

[2] Aksnes, Dag, W.: Studies in Innovation, Research and Education, Working Paper no. 6/2005

[3] Rapmund, A. (2004): Patenter som dokumenterer samarbeid mellom Norge og Nord-Amerika (Patents documenting cooperation between Norway and North America). Working Paper, Studies in Innovation, Research and Education, 2004

cialisation has become more positive in these environments, and university employees have acquired more knowledge of patenting and of how it can be adapted to an academic career[4]. In 2001, seven per cent of university-employed researchers said that their research had led to patents. An equal proportion replied that the research had led to the establishment of companies[5]. Along with funding from business and industry, cooperation with researchers in this sector plays a major role in whether researchers utilised their results commercially.

3.4 Resources for R&D

Preliminary figures show that investment in R&D in Norway, measured as total domestic expenditure on R&D, amounted to NOK 27.3 billion in 2003, NOK 2 billion of which was funded from abroad. This represents an increase of NOK 2.8 billion compared with 2001. When adjusted for price increases during this period, this constitutes a growth in real terms of 3.8 per cent per year.

Taking price increases into account, financial resources channelled into research and development have risen by around 130 per cent in Norway during the past two decades. This is more or less the same as the growth in the OECD area and somewhat higher than for the EU in total, but lower than in the countries that have invested most heavily in R&D. Both Finland and Japan have more than quadrupled their spending in the same period (see figure 3.10). A particularly large increase in research investment took place in the last half of the 1990s, with an annual growth in real terms of 4.6 per cent in the OECD area between 1994 and 2001. The subsequent decline in economic activity has slowed down R&D growth, and preliminary figures indicate an increase in the OECD area's R&D expenditure of 2.8 per cent from 2001 to 2002.

R&D expenditure in Norway amounts to 1.75 per cent of the GDP, which represents an increase from 2001 when the R&D proportion was 1.60 per cent. However, figure 3.11 shows that Norway still invests fewer resources in research and development than most comparable countries in relation to society's total value creation. Finland invested 3.46 per cent and Denmark 2.52 per cent of the GDP in

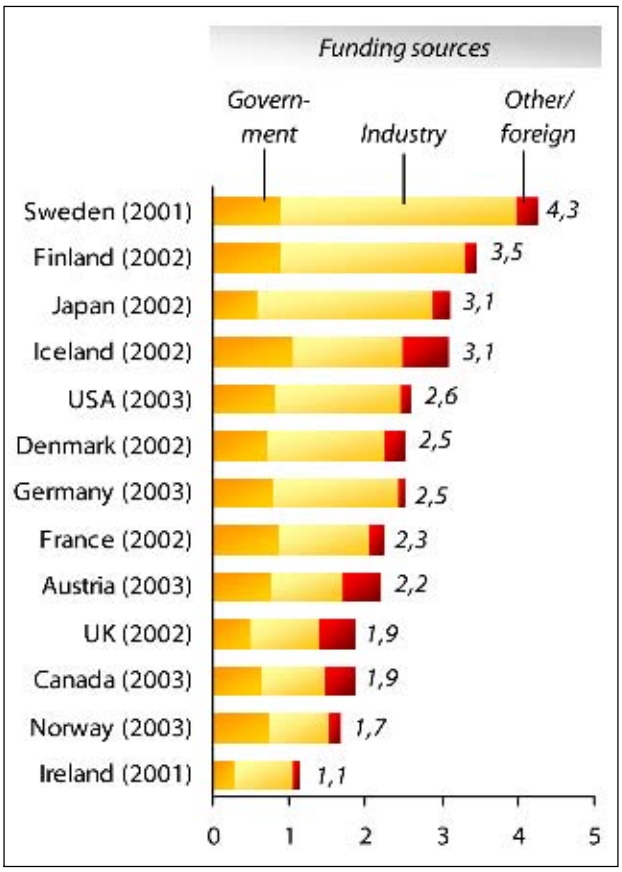


Figure 3.11 Total R&D expenditure in selected OECD countries according to funding source as a percentage of GDP, 2002

Source: OECD/Studies in Innovation, Research and Education

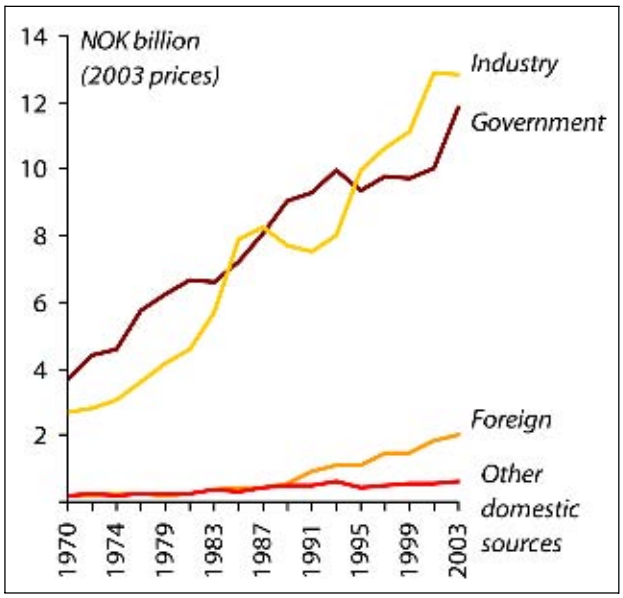


Figure 3.12 R&D expenditure in Norway according to main funding source, 1970–2003, NOK million in fixed 2003 prices

Source: Studies in Innovation, Research and Education

[4] Gulbrandsen, M. (2003): Jeg gjør jo ikke dette for å bli rik av det. Kommersialisering av norsk universitetsforskning – en intervjustudie (I'm not doing this to get rich. Commercialisation of Norwegian university research – an interview study). Norwegian Institute for Studies in Research and Higher Education, 6/2003

[5] University study 2001, reproduced in Rapmund (2004)

research and development in 2002. Sweden's GDP proportion was 4.27 per cent for 2001. The most recent updated figure for the OECD average is for 2002 and amounts to 2.26 per cent.

Figure 3.11 clearly shows that the low R&D expenditure per inhabitant in Norway is primarily due to the fact that business and industry is investing far less in research and development – corresponding to 0.82 per cent of the GDP in 2003 – than is the case in R&D-intensive countries such as Sweden and Finland, with respectively 3.07 and 2.40 per cent of the GDP, and the USA with 1.64 per cent. Norway is also well below the OECD average of 1.40 per cent. This can partly be explained by the country's business structure and the large number

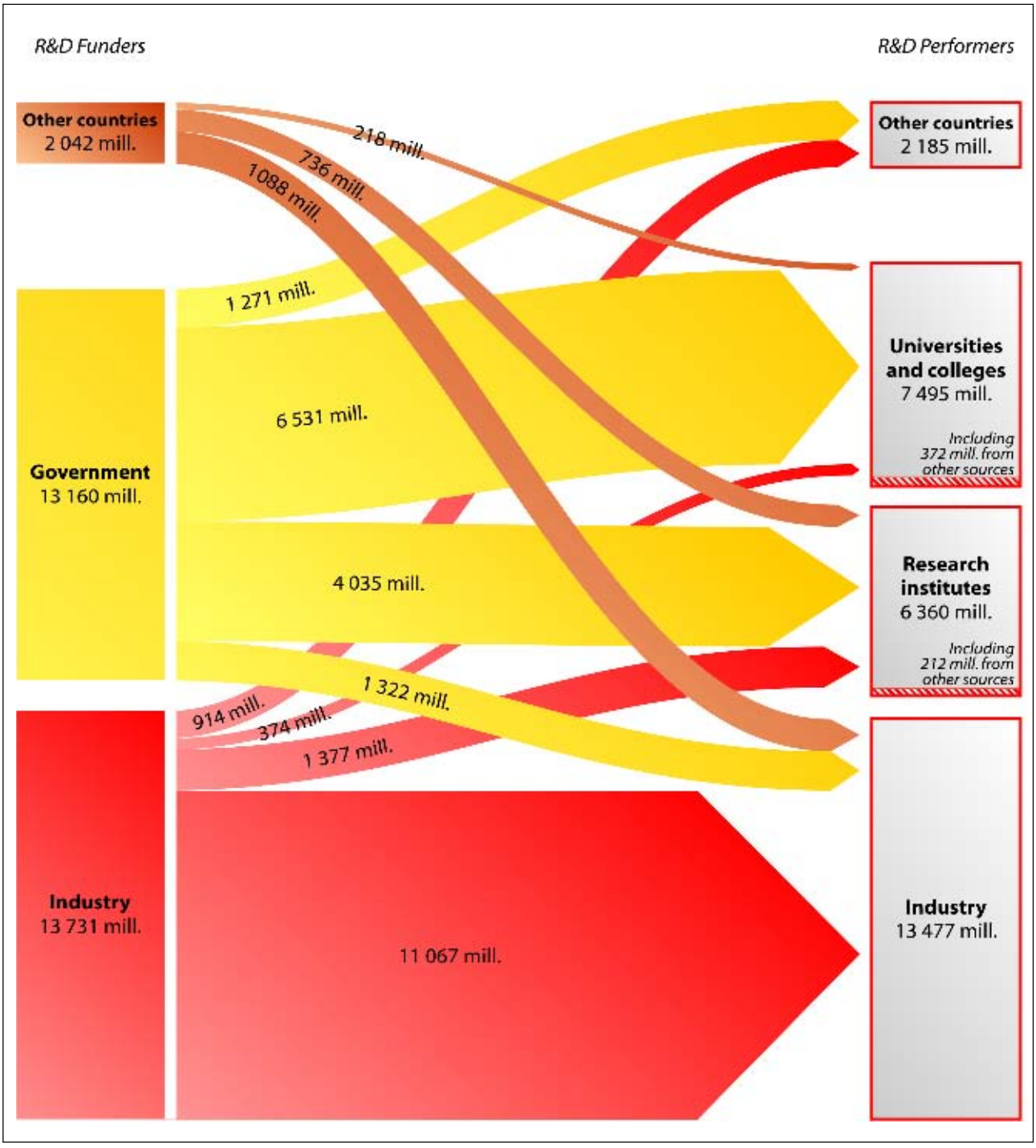


Figure 3.13 Funding flows in R&D, 2003, NOK million

Source: Studies in Innovation, Research and Education/Statistics Norway

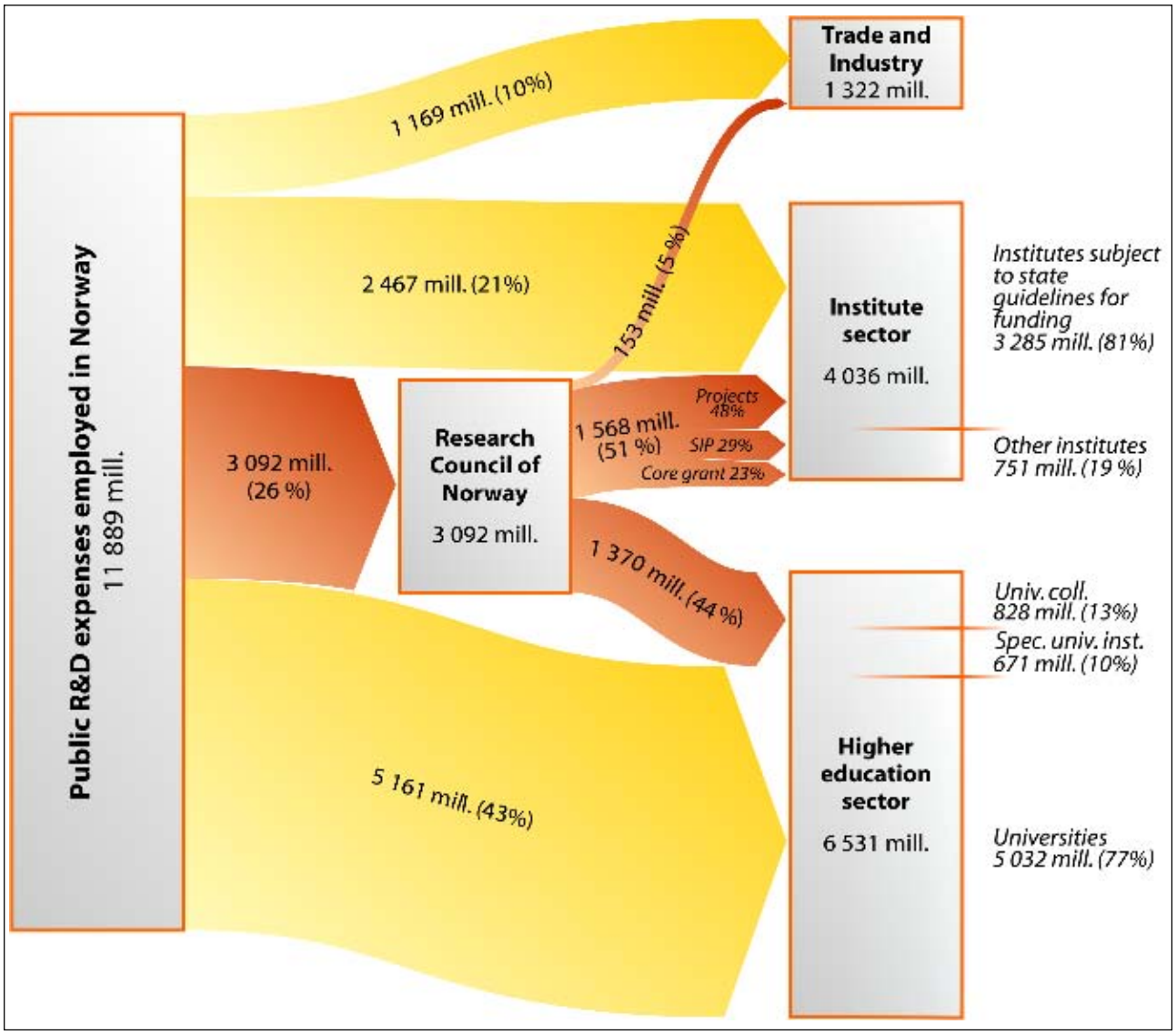


Figure 3.14 Channelling of public investment in R&D, 2003, NOK million

Source: Studies in Innovation, Research and Education 2004–2005

of small companies in Norway (see chapter 6 for a more detailed analysis of this).

The authorities' investment in R&D – corresponding to 0.76 per cent of the GDP in 2003 – represents a high level by international standards and is well above the OECD average of 0.68 per cent (2002). Only six OECD countries have higher public investment in R&D than Norway (Finland, France, Iceland, Germany, Sweden and the USA), and only Iceland invests more than one per cent of the GDP.

While state authorities accounted for a larger proportion of society's total R&D investment than business and industry up to the middle of the 1980s, business and industry has invested more in R&D than the authorities since the middle of the 1990s. Business and industry's R&D investment is vulnerable to trade cycles, and declines during a downturn in the economic situation – for instance at the end of the 1980s and after 2001. Despite stagnation in its expenditure on R&D up to 2003, business and industry still accounted for a larger amount of this investment in 2003 than the authorities (figure 3.12).

While business and industry's R&D expenditure grew by 15 per cent from 1999 to 2003, public expenditure has increased by more than 20 per cent. An examination of government funding for research in the 1990s reveals that the growth in Norway was somewhat higher than in the OECD area in total but lower than in the countries where the authorities have invested most proactively – particularly Japan and Finland. In some countries public funding has declined (the UK) or has stayed at almost the same level (Sweden) in this period.

After 2000, public investment in R&D has acquired greater importance in the OECD area. It is principally the USA, Canada and Korea that account for the large increase in public R&D expenditure.

In addition to R&D funding by the authorities and business and industry, other countries invested NOK 2 billion in Norwegian R&D – an increase from NOK 1.8 billion in 2001, cf. figure 4.1. NOK 460 million of this comes from the EU's framework programme. In addition, other Norwegian players (foundations etc.) invested NOK 580 million in R&D in 2003.

3.5 Funding Norwegian research

3.5.1 Funding flows

Not all public research allocations are made to research in state institutions, nor is the expenditure of business and industry entirely devoted to R&D conducted in the business world. This may be the general rule, but figure 3.13 shows that business and industry buys R&D from other sectors for considerable amounts – NOK 1.3 billion from the institute sector and almost NOK 400 million from the higher education sector – in addition to purchasing R&D from abroad for a little over NOK 900 million.

Half the authorities' allocations to research are granted to research performed at universities and university colleges (NOK 6.5 billion). Figure 3.14 shows that NOK 5.1 billion of this is channelled directly to universities and university colleges, while NOK 1.4 billion goes via competition-based allocations in the Research Council of Norway. Compared with most other OECD countries, the higher education sector in Norway receives a relatively large share of the funding granted to research over the basic budgets, and a low proportion through competition-based allocations.

Furthermore, 30 per cent of the authorities' R&D grants are given to research performed in the institute sector, and ten per cent to that carried out in business and industry. Government expenditure on R&D in business and industry in the OECD area has declined since 1991 – mainly in the USA and the larger European countries. However, in some smaller economies the state has begun to play a larger role in national innovation systems, and government-funded R&D in business and industry is increasing in these countries (Finland, Australia). In addition to its direct grants for financing research, the state also contributes to increasing research in business and industry through the so-called *Skattefunn* scheme, cf. subsection 6.3.2. The total loss of revenues resulting from the scheme is presumed to amount to between NOK 3.5 and NOK 4 billion in the period 2002–2004, of which around NOK 1.8 billion has been budgeted as loss of revenues for 2004.

3.5.2 The Ministries' responsibility for funding research

Public funding of research is based on the so-called sector principle. This principle entails each individual ministry assuming prime responsibility for research in and for its sector/areas of responsibility. The ministries have both a long-term responsibility for research for the sector – the broad sector responsibility – and a responsibility for research that meets the ministry's own needs for a knowledge base for policy development and administration. Sector responsibility implies maintaining an overview of the knowledge needs of the sector, securing funding and promoting international research cooperation.

Sector responsibility extends beyond the state sector and can cover research for the private and municipal sectors. For example, this means that as the body responsible for the education sector, the Ministry of Education and Research is also responsible for research into and about primary and lower secondary education, even though responsibility for this part of the education system is mainly assigned to the municipalities. Educational research must reflect the importance of education for all the sectors and must create the conditions for cross-sector research. The Ministry of Agriculture and Food is responsible for research that benefits private businesses in the sector. All the ministries have a sector responsibility for the environment, which in a research context means that they assume an independent responsibility for conducting research geared towards reducing the environmental problems in their own sector.

The evaluation of the Research Council of Norway that was presented in December 2001 was critical as to how the ministries carried out their sector responsibility. In addition to pointing out that the ministries took responsibility for long-term basic research to varying degrees, it was also stated that they only to a small extent managed to differentiate between the responsibility for long-term research and that for ongoing studies. The Fund for Research and Innovation has been a significant instrument in strengthening long-term basic

Box 3.1 The Norwegian research system in an international perspective

Technopolis, an international evaluation company, has studied how the management and coordination of research and innovation policy is organised in Norway, the Netherlands, the UK, Sweden, Denmark, Ireland, Canada and Finland. The results were published in 2003 in the report *Research and Innovation Governance in Eight Countries*.

Compared with most other countries, the government in Norway has excellent opportunities to coordinate at government level as a sub-committee has been set up for research. The Norwegian system allows the formulation of broad *national* priorities in research and innovation policy. However, the report emphasises that the successful functioning of the coordination instrument is dependent on the abilities of those involved.

Norway has a research council that is responsible for the entire range of research-related issues – from basic research to innovation. This provides the opportunity for coordination and for linking basic research with research-based innovation. There is no overall budget handling of the research budget in Norway, and Norwegian budget coordination is defined as medium-strong. For example, when compared with Norway, both Denmark and Finland have strong budget coordination.

Technopolis' study presents Norway and Sweden as extremes in the way in which the ministries control their allocations through research council level. While Swedish ministries are extremely reluctant to give guidelines as to how funds are to be used, the study points out that some Norwegian ministries often provide very detailed provisions, both in the form of allocation letters and in ongoing communication. Reference is made to the fact that this practice reduces the Research Council's possibility to see the ministries' allocations as a cohesive whole and to think in an overall perspective. The study also states that the Norwegian practice can be related to the fact that the Research Council serves sector ministries whereas in other countries these ministries have more direct contact with research communities.

research – both in general and within the thematic priorities (see section 3.5). Together with other ministries and the Research Council, the Ministry of Education and Research has reviewed the ministries' work on research issues. One main point was to determine what sector responsibility actually entails, including clarifying the understanding of the difference between «broad sector responsibility» and more ongoing studies and assignments. A report and guidelines were compiled as a result of the review, and these are intended to serve as an aid in the ministries' work on research issues.

The sector principle means that research forms an integral part of policy formulation in the various sectors. At the same time the principle – and consequently the division of research funds into many grants – generates challenges regarding the coordination of the research assignments, which often concern many sectors. In addition to its general responsibility for basic research through allocations to the higher education sector and to the Research Council of Norway, the Ministry of Education and Research is also responsible for coordinating research policy at government level. The Ministry of Trade and Industry is responsible for coordinating the innovation policy, and there is good interaction between these policy areas. The coordination of research policy has been strengthened in recent years by the establishment of the Fund for Research and Innovation and by the development and follow-up of national strategies and priorities.

There is considerable variation in the ministries' use of research as a policy instrument and in the volume of research the ministries finance. Around NOK 14.2 billion is to be allocated to research in 2005. Table 3.1 shows each ministry's R&D allocations in the central government budget in 2005 and confirms that there are large variations between the ministries. In 2005 about 55 per cent of government R&D funding will be channelled via the budget of the Ministry of Education and Research, around eight per cent via that of the Ministry of Trade and Industry, around seven per cent via that of the Ministry of Health and Care Services, and around 6 per cent via that of the Ministry of Defence.

The last few years have shown a substantial growth in grants to research via the budget of the Ministry of Education and Research. This is connected to the financing of the Quality Reform in the higher education sector, the transfer of the Norwegian fee to the EU's framework programme from the Ministry of Trade and Industry to the Ministry of Education and Research, and not least to the fact

that the returns from the Fund for Research and Innovation are allocated via the budget of the Ministry of Education and Research.

3.5.3 The Fund for Research and Innovation

The Fund for Research and Innovation was established in 1999 with a capital of NOK 3 billion. The main purpose of setting up the fund was to provide a basis for long-term stable funding of research activities, cf. Proposition no. 67 to the Storting (1998–99) concerning modifying priorities and additional grants in the central government budget, 1999. Since its establishment the fund has grown rapidly and its returns constitute a major part of all government grants to research (over 14 per cent in 2005).

From 1 January 2005 the total capital in the fund comprises NOK 36 billion. The yield from the fund in 2005 is almost NOK 2 billion, NOK 910 million of which is compensation for the loss of research funds from the state lottery. In 2005 just over NOK 400 million of the returns from the fund will be channelled directly into universities and university colleges, while more than NOK 1.5 billion is to be distributed through the Research Council of Norway. Figure 3.15 shows the distribution of the returns from the fund in 2005. The Government is not proposing to make any changes between the Research Council and university and university college institutions with regard to the distribution of returns from capital that has already been injected.

Table 3.1 The ministries' research funding, 2005

NOK million	
Ministry of Education and Research	7 850
Ministry of Labour and Social Affairs	163
Ministry of Children and Family Affairs	56
Ministry of Finance	77
Ministry of Fisheries and Coastal Affairs	617
Ministry of Defence	880
Ministry of Health and Care Services	938
Ministry of Justice and the Police	34
Ministry of Local Government and Regional Development	158
Ministry of Culture and Church Affairs	82
Ministry of Agriculture and Food	450
Ministry of the Environment	391
Ministry of Modernisation	35
Ministry of Trade and Industry	1 175
Ministry of Petroleum and Energy	433
Ministry of Transport and Communications	200
Ministry of Foreign Affairs	451
State banks	173
Total	*14 199*

Source: Central government budget

Box 3.2 Relationship between central government budget analyses and R&D statistics

Public R&D funding can be examined from two standpoints. The R&D statistics take the recipients of government R&D funds as their starting-point. The studies are accounts-based and are carried out when the activity has been completed. However, the point of departure for the central government budget analysis is the funding source. It gives information on government R&D grants for the coming year – in other words before the resources have been utilised – and is based on budget documents and other information.

The central government budget analyses provide information on the purpose of the allocations, while R&D statistics describe the actual use of the resources. The central government budget analyses therefore generate greater uncertainty than the R&D statistics. The central government budget figures contain estimated R&D grants for sources abroad, while the national R&D statistics only register research conducted in Norway. For instance, fees for the EU's framework programme for research will be registered in the central government budget analysis, while funds to researchers in Norway through the framework programme are recorded in the R&D statistics. Resources from counties and municipalities are not included in the central government budget analyses but are incorporated under government sources in the R&D statistics. The differences between the two methods of quantifying R&D funding means that the central government budget analyses and the R&D statistics produce varying results. In recent years the central government budget analysis has given higher figures than the R&D statistics.

As the rapid development of the fund's capital indicates, the Government has in recent years given priority to channelling large parts of the increase in research resources through the fund. The capital in the fund is invested as a government deposit loan. Each individual capital appropriation is given a fixed interest rate corresponding to the interest on long-term government bonds, with a ten-year fixed-interest period. Interest earnings for each year under the Ministry of Education and Research's budget are offset by corresponding interest expenses for the state. In real terms there is no annual income for the government from the fund, and its construction is thus a technical budgeting method that aims to achieve long-term earmarking of resources for the fund's purpose.

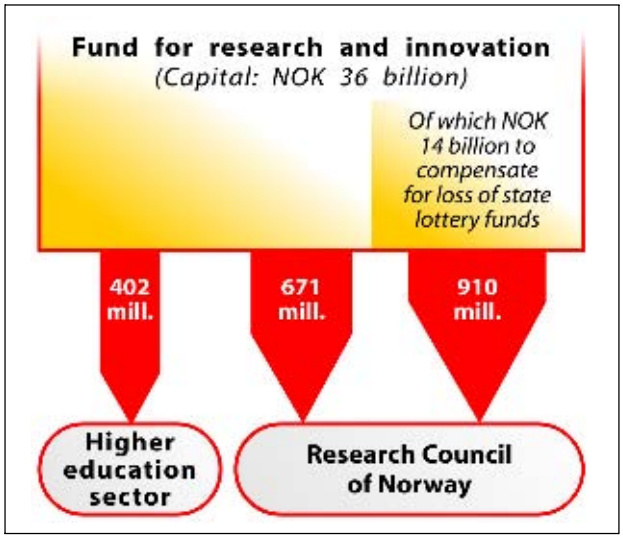


Figure 3.15 Distribution of the returns from the Fund for Research and Innovation, 2005, NOK million

Source: Proposition no. 1 to the Storting (2004–2005)

The yield from the fund has made it possible to implement the research policy priorities from the previous report on research, partly through direct grants to universities and university colleges and partly through the Research Council. The NOK 910 million that replaces the income from the state lottery is handled as ordinary allocations with relatively detailed guidelines to the Research Council of Norway. The remaining resources from the fund through the Research Council have been assigned general guidelines and give the Council the opportunity to make independent, comprehensive and long-term assessments. The principal guidelines for the fund state that the returns are to be specifically employed to meet prime research policy priorities. This entails quality-enhancing measures, cross-sector initiatives, long-term basic research in general and long-term research in the four the-

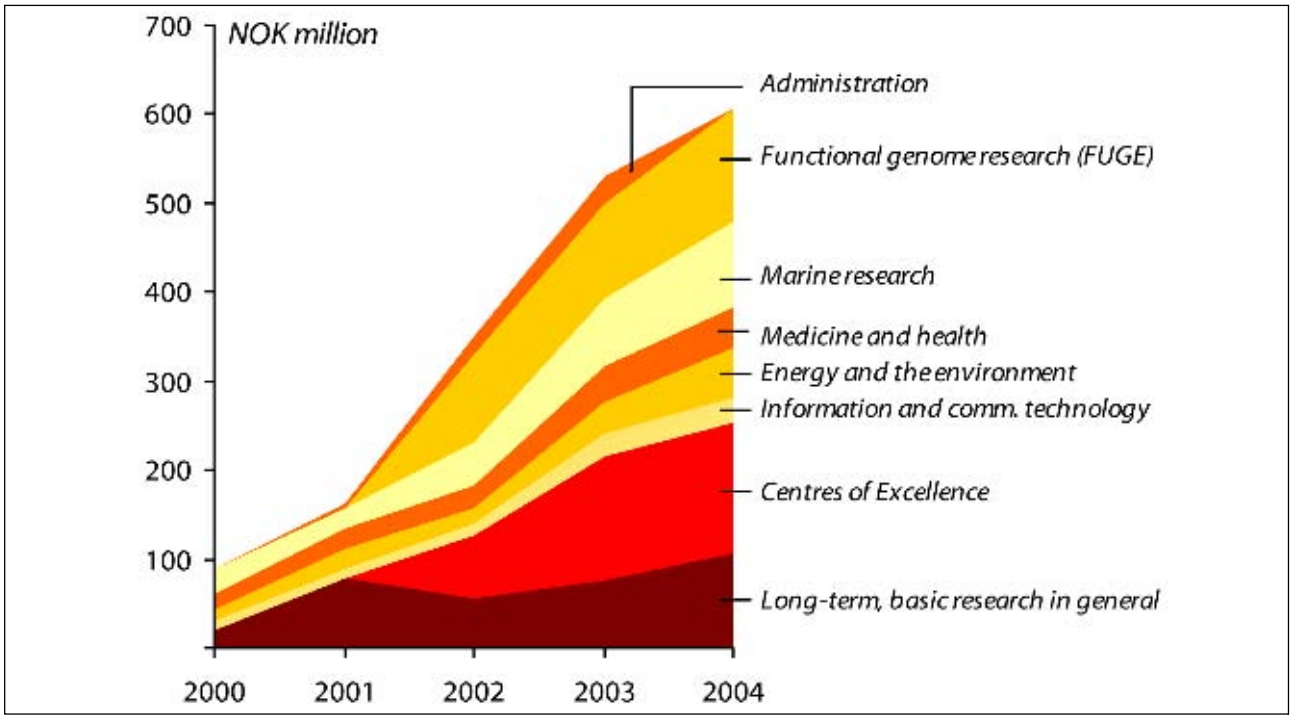


Figure 3.16 Distribution of the proportion of the returns from the Fund for Research and Innovation channelled via the Research Council according to prioritised areas, 2000–2004, NOK million in current prices, and excluding compensation for loss of research funds from the state lottery

Source: Research Council of Norway

matic areas that were assigned priority in the previous research report.

The yield from the fund finances extensive research of relevance to the various sector ministries. Investment in functional genomic research (FUGE) is an example of a cross-sector initiative financed by the fund, while the scheme concerning the Centres of Excellence is another policy instrument funded by the same means. Resources have also been earmarked to strengthen long-term petroleum research through the fund. Figure 3.16 shows how the returns from the fund (those channelled through the Research Council) are distributed according to prioritised area.

The yield from the research fund will also in the future represent a significant tool in the follow-up of the overarching priorities in the research policy (see chapter 2).

Published by:
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Publication number: F-4185/2 E
Print: PDC Tangen, 04/2005 – circulation 1 000

Figures and cover illustration: Jørgen Carling
The cover illustration is based on a photograph of
aluminium alloy by engineer Przemyslav Teodor
Zagierski