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Lisa Scordato

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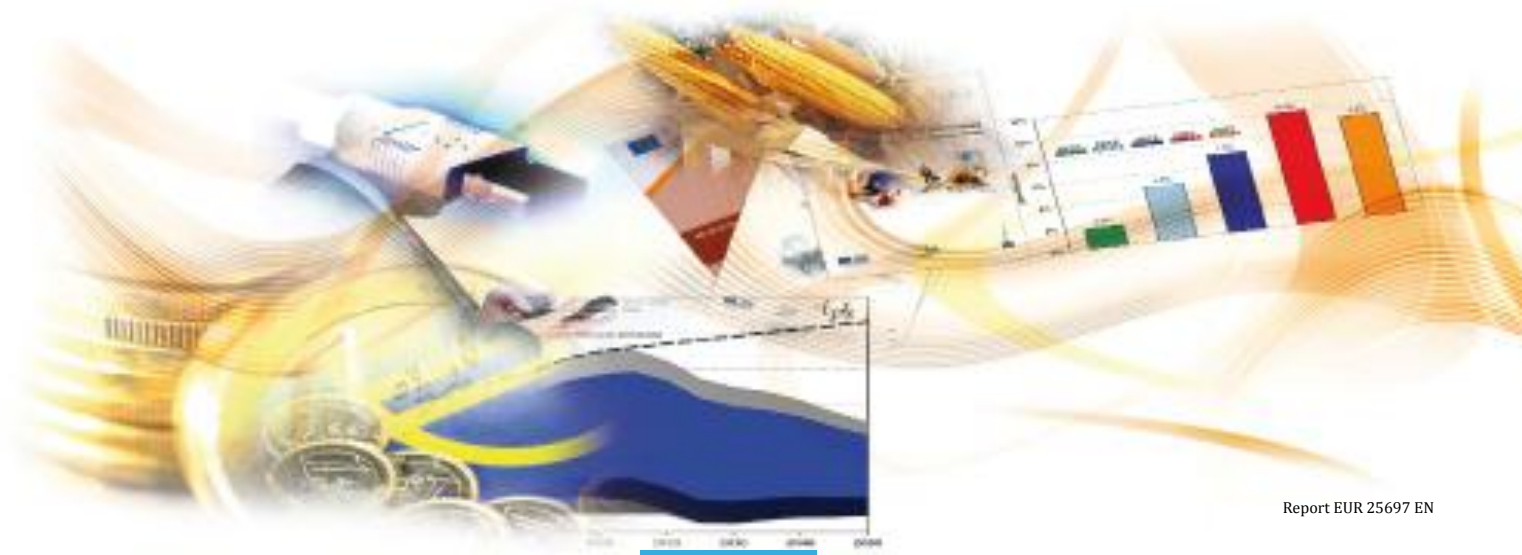

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Executive Summary

The macroeconomic performance of the Norwegian economy has remained strong in the current financial climate. In contrast, its low score on a series of standard R&D and innovation indicators persists. This report looks more closely at the state of the Norwegian RDI system.

At €5.4b (NOK42.8b) in 2010, total R&D investment in Norway is more than double the EU-27 average in terms of per capita spending. It remains however lower in terms of proportion of GDP (1.8%), despite recent increases. The increase was especially pronounced between 2007 and 2009 but has slowed since the financial crisis. The performance of RDI is distributed somewhat differently in Norway than for other countries. In 2009, the Industrial sector accounted for 43% of total R&D expenditure, the Higher education sector 32%, and the Institute sector 25%. Sixty-four thousand Norwegians were involved in R&D work in 2009, accounting for 36 000 full time equivalents (FTE). The number of doctorates (all fields) awarded by Norwegian HEIs exhibits a high annual increase over a period of several years, from around 650 at the turn of the century to 1330 in 2011. One third of the doctorates are foreign nationals, up from around 20 per cent in the early 2000s. 238 new doctorates were awarded per million inhabitants in 2009.

In brief, the Norwegian system's relative strengths are in human resources, an attractive research system, financing and support and entrepreneurship. Areas of relative weakness are found within private sector investments, patents, innovators and results.

The goal of attaining the OECD and EU averages in R&D investment has dominated the Norwegian RDI policy discussion for more than a decade. The explicit goal of reaching the 3 per cent target (i.e. R&D investment as proportion of GDP) has however weakened during the last couple of years, although it still remains a long-term goal. Norway remains a member of "moderate innovators" and the "slow growers" in terms of Innovation Union Scoreboard (2010).

Norway's R&D strategies are defined in periodical (every four years) white papers. The latest white paper, *Climate for research* (Report No. 30, (2008-2009)) addresses the need to meet global challenges. It places particular emphasis on the environment, climate change, oceans, food safety, and energy research. The goals are for a large part based on the priorities that were set down in the previous white paper, *Commitment to* Research (Report No. 20 (2004-2005)). However, they exhibit an increased focus on the challenges faced by the public sector and on global perspectives of research. A new White paper is being elaborated and will be presented to Parliament in the spring of 2013. At the same time, there has been a further focusing on the local levels. The counties have taken on a more central role in initiating, funding and implementing regional innovation policies. A key role is to administer the Regional Research Funds that were established in 2010 in order to promote regional innovation and regional development by fostering R&D within the priority areas of seven regions.

The main structural challenges of the Norwegian innovation system highlighted in this report are:

- shortage of science and engineering graduates;
- increasing industrial R&D, and

- restructuring of the economy.

With regard to the first challenge, the government has focused on this issue for a number of years and the challenge is pervasive in policy debates and documents. The interest of students in S&T subjects and careers has increased as a consequence of greater general attention paid to the issue both at the secondary and, more recently, at the tertiary levels. Several measures target the position of scientific and technological subjects in secondary education, as parts of a "Strategy for a Joint Promotion of Mathematics, Science and Technology" which has been in operation and continually updated since 2002.

Despite these efforts the average annual growth between 2000 and 2008 in tertiary graduates in science and engineering stood at 0.2% in Norway, which was below the EU average of 3.3% in the same period. On this indicator Norway also performs significantly below its Nordic neighbours. The average annual growth for Sweden was 1.5%, for Denmark 1.7%, for Finland 6.2% and for Iceland 4.0%.

The aggregate R&D intensity of the Norwegian business sector is relatively low, and increasing industrial R&D has been perceived as a key challenge for some time. There has been some positive development in recent years, with BERD as percentage of GDP increasing from 0.82 in 2006 to 0.95 in 2009, it is clear that the R&D intensity of the business sector remains low. It should be noted, however, that Norwegian policy makers have increasingly recognised that the low level of industrial R&D should be seen against the backdrop of the country's industrial structure which is characterized by a high share of raw material-based activities that are knowledge-intensive, but not R&D intensive.

A main issue in innovation policy debates in Norway is the country's strong dependence on resource-based export industries in general and the petroleum sector in particular is. While the strong position of the Norwegian economy in resource-based sectors has proved to be a strong asset during turbulent economic times worldwide, the Norwegian economy will have to diversify and develop strong positions in both incumbent and new knowledge-intensive sectors and niches. An extensive debate has taken place during the last couple of years. This puzzle centres on the apparent paradox that, while Norwegian scores are low on almost all standard innovation indicators, its economy performs better than almost anywhere else. It is generally assumed that part of the explanation lies with the industrial structure of the country. Norway's resource-oriented economy tends to subdue the contribution of more R&D industry to the overall economic product. The concern is that indicators do not adequately capture the assets and specific sources of innovativeness in resource-based economies as the Norwegian. Nevertheless, concerns persist that the Norwegian economy may not be sufficiently innovative to remain competitive in the longer term.

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1 Introduction

Norway is a small open economy. It has a population of 4,937,000 inhabitants (2011), or about one per cent of the EU-27 population. Norway participates in the European Union's single market via the European Economic Area (EEA) agreement. Its Gross Domestic Product (GDP) per capita in 2010 was € 63800 (as against € 24500 in the EU). Real GDP growth increased in Norway during the last three years, from a low -1.7 in 2009 to 2.7 in 2011 (as against 1.8 for EU-27).

In 2010, total R&D expenditures were €5.4b (NOK42.8b)[1] or about 1.7% of Norwegian GDP. This was below the EU average of 2% in 2009. Norwegian industry accounted for 43% of the total R&D expenditures in 2010 (€2.3b or NOK18.5b). Norwegian BERD was lower than the EU average in 2009 (0.95% as opposed to 1.25% of GDP), although the shortfall is more than made up for by Norway's significantly higher GDP per capita.

Large scale investments are currently being allocated to research infrastructure in Norway to address the estimated investment needs of about €1.4b (NOK11b) for the period 2008-2017 (excluding operating costs). This follows on from a national strategy for research infrastructure (Tools for Research, 2008) and the resulting earmarking of funding from the Research and Innovation Fund.

Norway's main strengths are its human resources, with a very high degree of full time researchers in the labour force and a strong dynamic of new doctoral graduates. Norway is among the OECD countries with the highest educational level in the population and the number of employees with higher education qualifications in both the private and the public sector is increasing considerably.

Norwegian researchers have significantly increased their publication rates in the past decade. Since the mid-1990s Norway has seen the largest rise in impact with a current level around 9% above the world average. A larger proportion of Norwegian scientific publications is more highly cited than the EU average, according to the Innovation Union Competitiveness Report 2011. This development can be seen in light of the introduction (2004) of a funding model for Norwegian higher education institutions that links institutional funding in part to publications. The level of Norwegian patenting internationally is however below the EU average for PCT and EPO applications (Innovation Union Scoreboard, 2010). Norway joined the European Patent Convention effective 2008. Norway is currently working on policy white paper on Intellectual Property Rights (IPRs).

Innovation System Structure

There is a strong emphasis in the Norwegian research and innovation system on geosciences, biology and agricultural research. This in part is linked to importance of natural resources such as oil and gas, fish and minerals in the Norwegian economy. The development of petroleum related industrial activities in engineering and services have had a particularly strong imprint on the economic and R&D specialisation patterns of Norway. In addition, the areas of Health, Agriculture and Industrial production and technology account for a large share of government allocations, in accordance with General University Funds (GUF) objectives.

[1] Exchange rate NOK per 1 EUR: Annual average for 2010, NOK8.00. Source: Norges Bank.

The main actors and institutions, as well as funding flows within the Norwegian system of education, research and innovation are depicted in Annex 2. The national government plays an important role in the Norwegian research and innovation system. Its responsibility for research is organized according to the "sectoral principle", indicating that several ministries allocate sizable resources to research related to societal sectors under their respective responsibilities. Hence, research appropriations are widely distributed among several ministries, while the Ministry of Research and Education is the largest source of government research funds and is charged with the inter-ministerial coordination of national research policy and government's overall research funding. The Minister of Research and Higher Education heads the Government's Research Board of which the most research oriented ministries are permanent members, and which is a main institutional setting within Government for coordinating overall R&D policy. The authority and influence of the Board within the strongly sectoral funding structure are, however, limited. The establishment in 1999 of the Research and Innovation Fund did for a period of a decade make increasing funds available for allocations according to cross-cutting priorities. Nevertheless, concerns are often voiced about the weak coordination of governmental research funding, including by the OECD (OECD, 2008).

Ministries in addition to the Ministry of Research and Education that allocate large funds to research include, inter alia, the ministries for Trade and Industry, Health and Care Services, Oil and Energy, the Environment, Agriculture and Food, as well as Fisheries and Coastal Affairs. The Ministry of Health and Care Services has over a number of years increased its appropriations for research considerably and has now surpassed the Ministry of Trade and Industry as second-largest research ministry.

Overall responsibility within the Government for its innovation policy resides with the Ministry of Trade and Industry. The existence of general innovation policy is, however, less institutionalized and of more recent origin than that for R&D. While a need was identified in the early 2000s for a more integrated innovation policy across ministries and across the private and public sectors, the first White paper on innovation dates from 2009. The Ministry of Health and Care Services has launched strategies for innovation in the health and care sectors, emphasizing both improving the quality of services and business opportunities.

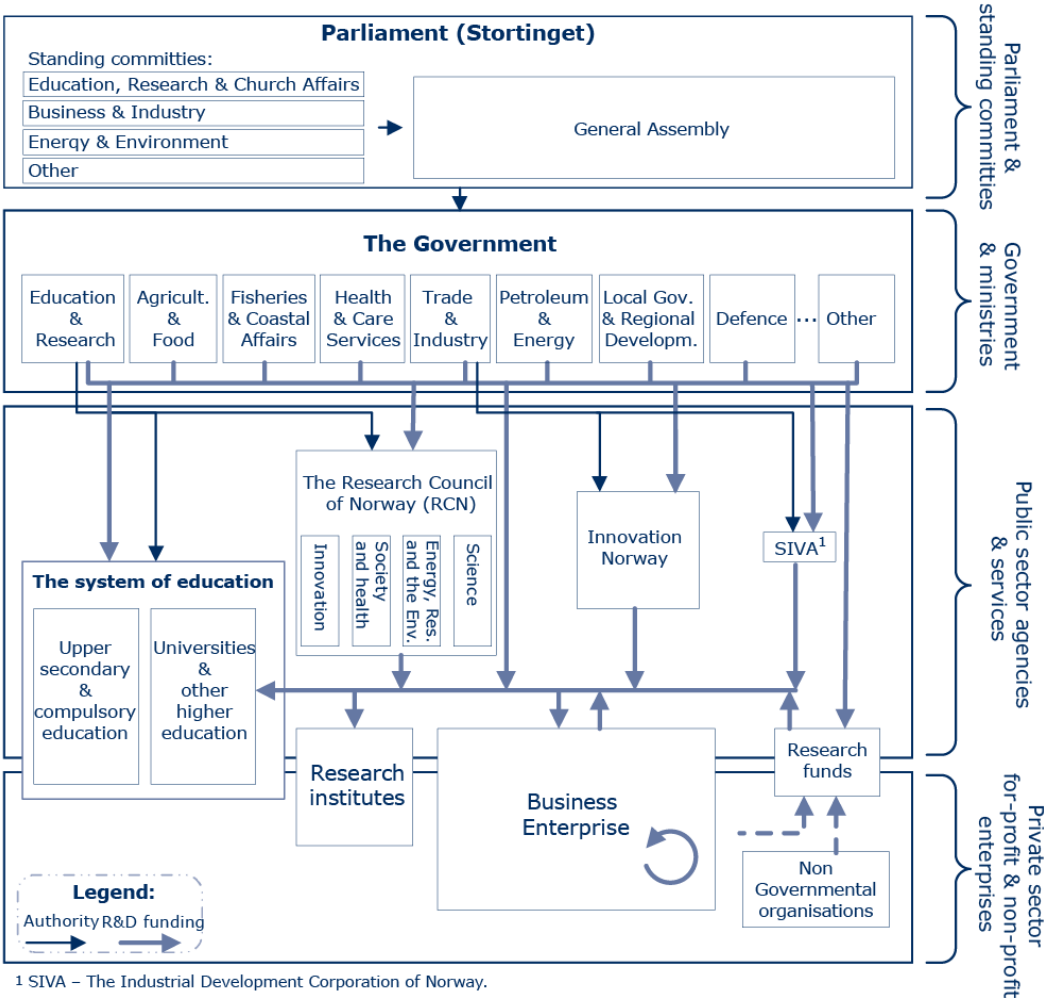
The Ministry of Local Government and Regional Development has overall responsibility for innovation policy at the regional level (there are 19 county administrations or *fylker*). In recent years, the counties have taken on a more central role in initiating, funding and implementing regional innovation policies as they in a reform of 2007 explicitly was given this responsibility and offered tools to implement R&D&I strategies at regional level. A key role is to administer the Regional Research Funds that were established in 2010 in order to promote regional innovation and regional development by fostering R&D within the priority areas of the seven respective regions.

Three actors below the ministerial level are the main institutions for implementing the research and innovation policies of Government. *The Research Council of Norway* (RCN) is the executive research policy agency in Norway. Its mandate is to establish and implement funding schemes for research, to provide the government with research policy advice, and to serve as a meeting place for researchers, research funders, and research users. The Ministry of Research and Education and the Ministry of Trade and Industry are the most important contributors to its budget, which was approximately €896m (NOK7b) in 2010. *Innovation Norway* and *SIVA* (the Industrial Development Cooperation of Norway) are the main public institutions that

provide support for innovation. Innovation Norway is owned by the Ministry of Trade and Industry and provides programmes and services with the objective of promoting innovation at the regional and national level. SIVA is involved in the provision of science parks, incubators, and services mainly to start-up firms.

The performance of RDI in Norway is typically divided between the Industrial, the Higher education, and the Institute sector.[2] In 2009, the Industrial sector accounted for 43% of the total annual R&D performance, the Higher education sector 32%, and the Institute sector 25%. (NIFU, 2011) There are relatively few large R&D intensive companies in Norway. Including University Hospitals, Universities carry out the lion share of research in the Norwegian Higher education sector (about 85% in 2009). A further 9% is performed by university colleges and 6% by specialised university colleges. The Institute sector covers several different types of institutions, including both privately and publicly funded research institutes. A major player is SINTEF which is one of the largest research institutes in Northern Europe.

Figure 1: Overview of the Norwegian system of education, research and innovation, 2011



Source: NIFU (2011)

[2] The Industrial sector excludes business-oriented research institutes, which are included in the Institute sector, but covers R&D performers in the Government and Private non-profit sectors. (NIFU, 2010)

2 Structural challenges faced by the national system

In strong contrast to the excellent macroeconomic performance of the Norwegian economy, stands its, in comparison, low performance on a large number of standard R&D and innovation indicators. Over the last seven years, Norway has been part of the European Innovation Scoreboard (now Innovation Union Scoreboard) group of "moderate innovators" with innovation performance and average annual growth in innovation below the EU-27 average. Its position as moderate innovator remains unchanged in the Innovation Union Scoreboard (IUS) 2010. Other countries grouped as moderate innovators in the EU are the Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain. Finland and Germany are in the group of countries showing the highest increase in their scores, while Norway belongs to the "slow growers" group. The Norwegian system's relative strengths are in human resources, an open, excellent and attractive research system, financing and support and entrepreneurship. Areas of relative weakness are found within private sector investments, patents, innovators and results.

Despite some changes in scores on some indicators, Norway's overall position has not significantly changed since the 2009 European Innovation Scoreboard. Nevertheless, the country still has, with its high GDP, high growth and low unemployment excellent economic results far better than almost all other countries.

The main structural challenges faced by the Norwegian innovation system are outlined below.

Shortage of science and engineering graduates

The number of new S&E graduates is far below the EU average, and declines in the past on this indicator continue, albeit at a lower rate, in the EIS for 2007. The share of female S&E graduates (28% in 2007) is particularly low; it is the lowest amongst the Nordic countries and substantially lower compared to other OECD countries. The government has focused on this challenge for a number of years and the issue is pervasive in policy debates and documents. Students' interest for S&T subjects and careers, in particular at the secondary level, but recently also in tertiary education, has increased as a consequence of campaigns and the general attention paid to the issue. Several measures target the position of scientific and technological subjects in secondary education, as parts of a "Strategy for a Joint Promotion of Mathematics, Science and Technology" which has been in operation and continually updated since 2002.

The average annual growth between 2000 and 2008 in tertiary graduates in science and engineering stood at 0.2 percent in Norway, which was below the EU average of 3.3 in the same period. On this indicator Norway performs significantly worse than its Nordic neighbours. The average annual growth for Sweden was 1.5, for Denmark 1.7, for Finland 6.2 and for Iceland 4.0 (Innovation Union Competitiveness report, 2011).

Noteworthy is the low level of unemployed human resources in science and technology as percentage of total unemployment. In 2009, the level was 1.3% in Norway whereas the average for the EU was 3.6% (Innovation Union Competitiveness report, 2011). This situation would indicate that there is a good match between job opportunities and S&T graduates. However, debates highlight

that the shortage of S&T engineers is a problem for the Norwegian economy and that this will only be sharpened in the future.

Increasing industrial R&D

The R&D intensity of the Norwegian business sector is relatively low, and increasing industrial R&D has been perceived as a key challenge for some time. Norway adopted the Barcelona 3% R&D intensity objective in 2005, which states that industrially funded R&D should account for 2% of GDP by 2010. Although there has been some positive development, with BERD as percentage of GDP increasing from 0.82 in 2006 to 0.95 in 2009, it declined again in 2010 to 0.73 per cent (in large part due to strong GDP growth), and it is clear that the R&D intensity of the business sector remains remarkably low. The BERD/GDP ratio is far below the EU average, which was 1.25% in 2009. (Eurostat, 2011)

It should be noted that, over the past few years, Norwegian policy makers have increasingly recognised that the low level of industrial R&D should be seen against the backdrop of the country's industrial structure. As pointed out in the latest Innovation Union Competitiveness report, the Norwegian economy is to a large extent characterised by resource-based industries which score low on the R&D intensiveness indicator. When it comes to the very important petroleum sector, the report stresses that "[t]he high profitability of companies (…) means that the ratio of R&D investments as percentage of turnover is low, despite corporate spending on R&D to a competitive level." (Innovation Union Competitiveness report 2011). The petroleum sector as well as other sector that are resource-based and export-oriented have high productivity and are highly *knowledge*-intensive as they make extensive and efficient use of highly advanced, research-based technologies, stimulated by such factors as the openness of the export sectors to global competition and the compressed income structure in Norway. While the heightened political awareness of the idiosyncrasies of the Norwegian industrial structure seems to have contributed to lowering the level of concern over the R&D intensity of the Norwegian business sector, increasing industrial R&D remains a central innovation policy objective.

Restructuring of the economy

The strong position of the Norwegian economy in resource-based sectors has proved to be a strong asset during turbulent economic times worldwide. However, the need of the Norwegian economy to diversify and develop strong positions in both incumbent-related and new knowledge-intensive sectors and niches is expected. An extensive debate has taken place during the last couple of years on the apparent paradox that the Norwegian economy performs, on one hand, better than almost all other national economies in the world, while Norwegian scores are low on almost all standard innovation indicators on the other. It is generally assumed that part of the explanation of the paradox is that standard innovation indicators do not adequately capture the assets and specific sources of innovativeness in resource-based economies as the Norwegian.

The need to foster growth in knowledge and R&D intensive sectors of the economy has been identified as a key challenge in the Norwegian research and innovation system (TrendChart Mini Country Report Norway, 2011). The OECD, in a comprehensive review of Norwegian innovation policy published in 2008, has strongly emphasised the need to restructure the Norwegian economy towards other knowledge based activities, in order to be able to sustain growth beyond the peak of oil and gas production (Erawatch policy mix report, 2010).

However, the highly profitable petroleum sector is presently the central motor in the Norwegian economy and one of the main explanations why the Norwegian economy fares better than most other Western economies during the present financial and economic crisis. New discoveries of oil and gas reserves, technologies for more effective exploitation of existing reserves, development of CCS technologies and lack of agreement on caps on climate gas release are factors that indicate that the demise of the "oil and gas era" in the Norwegian economy may still lie decades into the future. Both this sector and other strong, export-oriented and resource-based sectors the Norwegian economy (fishing, mining) are highly knowledge-intensive, providing a basis for continued productivity improvements within these sectors themselves, as well as for diversification into related and new knowledge- and R&D-intensive economic sectors.

Diversification of the Norwegian economy from the basis of its unique strengths is, inter alia, an issue of effectively stimulating the long-term viability and growth of new knowledge-based start-up companies. As the majority of large Norwegian companies have tended to fall back on their core business areas, the main actors in these innovation areas are SMEs, often spin-offs from major companies or research institutions. These companies struggle to succeed particularly in the commercialisation phase, and do not succeed in growing into medium large companies. Concern over access to venture capital is often raised in this context (TrendChart, 2009).

3 Assessment of the national innovation strategy

3.1 National research and innovation priorities

Norway's multiannual R&D strategies are defined in periodical (every four years) white papers to the *Storting* (Norwegian Parliament). The latest white paper *Climate for research* (Report No. 30 (2008-2009)) signals a new approach to defining national research policy objectives. It maintains that, while the 3% Barcelona objective should continue to be a *long term* goal, more emphasis should be placed on the quality and results of research and on how research benefits society. Against this background, it argues in favour of defining clear objectives within certain prioritised areas, such as solving global challenges, improving health and care services, and promoting welfare. Industrial R&D should be targeted towards specific industries where Norway has relative strengths and comparative advantages.

The white paper defines nine **research policy goals**. Five of these goals are thematic and four are generic. The thematic goals are to

- meet global challenges, with a particular emphasis on the environment, climate change, oceans, food safety and energy research;
- improve health, level social differences in health, and develop high quality health services;
- address welfare challenges and sustain research-based practise in the relevant professions;
- develop knowledge based industry in all regions; and

- strengthen industry oriented research within the areas food, marine, maritime, tourism, energy, environment, biotechnology, ICT, and new materials/ nanotechnology.

The goals that concern the whole research system are to

- enhance the quality of research;
- ensure the well- functioning of the research system;
- increase the internationalisation of research; and
- sustain efficient use of research resources and exploitation of results.

These goals are for a large part based on the priorities that were set down in the previous white paper on research *Commitment to Research* (Report No. 20 (2004-2005)). However, the current goals imply a slight shift of emphasis in research policy towards challenges faced by the public sector and global perspectives of research (ERAWATCH policy mix report, 2009). These priorities have, however, to limited extent, been implemented. The current government's policies have mainly focused on initiatives in the wake of the so-called "climate agreement" and increases in appropriations for responsive mode funding of academic research.

The present centre-left Government has announced that it will publish a new white paper on research in spring 2013. It has indicated that continuity with earlier policies and priorities is one concern that will be taken into account. Statements by the Minister of Research indicates that the concept of the "knowledge triangle" will claim a key role in framing policy, and that the shift from resource issues to productivity, output and effective application of research results will be continued.

The overall objective of Norwegian **innovation policy** is to support long term sustainability and protect welfare. This policy objective emerges in the first white paper in Norway dealing explicitly with innovation policy. The white paper was published in December 2008 with the emblematic title "*An innovative and sustainable Norway"*. The rationale for innovation policy, as outlined in this policy document, is the need to respond to the increasingly globalised challenges. The global challenges are viewed by policy makers as opportunities for developing new innovative products and services for society (TrendChart Country Mini Report Norway, 2011)

In the white paper, the government defines several innovation policy priorities, including

- innovation in small and medium sized enterprises (SMEs);
- entrepreneurship;
- employee-driven innovation;
- innovation in the public sector, especially in health and care services;
- industrial R&D;
- commercialisation;
- environmental innovation;
- intellectual property rights (IPR);
- design; and
- service innovation.

The government also expresses the ambitions to strengthen public support for innovation, and improve innovation policy by increasing the knowledge-base and establishing strategic councils in selected areas. (Report No. 7 (2008-2009) *An innovative and sustainable Norway*)

Over the recent years, R&D and innovation strategies have been developed for specific areas that represent strengths in the Norwegian economy. These include the strategy for oil and gas (OG21), energy (Energi21), climate (Klima21), and the maritime sector (Maritim21).

OG21, which was launched in 2001 on the initiative of the Ministry of Petroleum and Energy, was based on the idea that industry should be actively involved in developing strategies for R&D and technology development within the oil and gas sector. A model was developed in which a ministry-appointed board covering key actors within industry, education and research as well as in the policy system plays a key role. The board serves as advisor to the Ministry, and is responsible for bringing together relevant actors in a unified approach to promote competence building, R&D, and innovation, based on a national technological strategy for the whole sector.

Energi21, Klima21 and Maritim21 have all been developed on the basis of the same model as OG21 (*Forskningspolitikk*, Vol. 4, 2011). Energi21 was launched by the Ministry of Petroleum and Energy in 2007; Klima21 was introduced as a joint government initiative in 2009; and Maritim21 was launched in 2010 by the Ministry of Trade and Industry.

Another area where a national strategy has been issued recently is marine bio-prospecting. The strategy was published in 2009, and had been prepared by the Ministries of Fisheries and Coastal Affairs, Education and Research, Trade and Industry, and Foreign Affairs, in cooperation with the Ministry of the Environment. Marine bio-prospecting is viewed as an important field that may contribute to new and sustainable wealth creation in the country, and the strategy maintains that funding for research and support for commercialisation relating to marine bio-prospecting will be increased.

Government is presently making an overall review of its IPR policy, having announced that it will present a White paper on IPR to Parliament in spring 2012. This horizontal policy area is one where Norway has performed unfavourably in European comparisons.

When it comes to the overall policy mix, Norway generally seems to have a balanced and efficient set of R&D and innovation policies. The OECD report on the Norwegian innovation system that was published in 2008 maintained that the country had a broad and fairly complete set of instruments to support research and innovation. The main criticism was the lack of demand-oriented instruments. (ERAWATCH country report 2009)

Long-term strategic research and R&D cooperation are the two most prominent areas for public support, according to the ERAWATCH country report for 2009. The report points out that the country also has a well-developed system of advisory services and provides significant funding for cluster initiatives. In terms of thematic priorities, a relatively high share of policy measures is reported to target the three areas environment, energy and health. (ERAWATCH country report, 2009)

Norway has several policy measures aimed at stimulating business sector R&D. They include large-scale programmes targeting specific strategic industries or thematic priorities, “open” programmes for research-based innovation, and a tax deduction scheme for industrial R&D. Still, the argument has been raised in recent years that there is not sufficient support for industrial R&D. This was, for example, a key criticism of the 2011 national budget. (ERAWATCH report, 2010)

Main developments in recent years include increased emphasis on support for climate and energy research and for regional innovation. The 2010 national budget saw a marked growth in public R&D funding, and this growth was to a significant extent linked to increases in funding for climate and energy research and the establishment of Regional Research Funds. The objective of the Regional Research Funds is to increase R&D investments and promote innovation at the regional level. (NIFU STEP, 2009)

There is a relatively good match between current policy priorities and the structural challenges that were identified in the previous chapter. Increasing the number of S&T graduates is embedded in the overriding priorities in current white papers on research and innovation, reflecting a broad political recognition that continued efforts to strengthen recruitment to S&T studies are needed. As mentioned in chapter 2, a government strategy to promote mathematics, science and technology was introduced in 2002. The white paper on innovation refers to this strategy, and argues that new initiatives should be considered when the strategy ends in 2009. This has been followed up on in the form of a new strategy that is entitled *Science for the future* and runs from 2010 to 2014. A main focus of the new strategy is to improve science teachers' competence in primary and secondary education.

Increasing industrial R&D is, as we have seen, defined as a key innovation policy priority. However, the timeframe for reaching the quantitative goal that private R&D investments should account for 2% of GDP has been extended and reframed as "long-term" target, with no pre-defined target year.

3.2 Trends in R&D funding

Financial resources for research are set on a yearly basis in the National budgets, presented to the Parliament in the autumn. For this reason there is little room for long term predictability of research funding.

Norway's total R&D costs in 2010 were €5.4b (NOK42.8b) corresponding to about 1.7% of gross domestic product (GDP). EU average in 2009 was about 2%. Industry carried out R&D totalling €2.3b (NOK18.5b) in 2010, 43% of the total R&D costs. In 2009 Norwegian BERD at 0.95% of GDP was lower than the EU average at 1.25%. The global economic crisis hit Norway less severely than many other EU and OECD countries. The Norwegian economy has been particularly resilient during the financial crisis with a relatively shallow recession and moderate increase in unemployment (OECD, 2010). The economic crisis has not had any significant impacts on public R&D funding. Changes in GERD R&D intensity between 2008 and 2009 showed a small (nominal) increase with 4% (European Commission, 2011).

In Norway, the proportion of firms co-operating with the public research infrastructure, especially research institutes, is high and above the OECD average. The proportion of Higher Education Expenditure on R&D (HERD) funded by industry is similar to that in the USA and just below the OECD average. In 2007, industry funded approximately about €60m or 11% of the research in Norwegian universities and also provided 22% of the institute sector's income (NIFU STEP R&D statistics).

In the 2008 R&D survey of the Norwegian industrial sector the enterprises were asked whether they expected the financial crisis to affect their R&D expenditures in 2009. Two thirds of the companies reported that they expected the financial crisis to have no impact on R&D activity. It seems, however, that the companies were too

optimistic, as reported figures for 2009 are lower than the estimates in the survey (NIFU, 2011).

Foreign funding accounted for 8% of total R&D expenditure in Norway in 2009. 17% of total foreign funding came from the European Commission. (NIFU, 2010)

The 3% Barcelona target was officially adopted by the Norwegian government in 2005. Six years later no progress towards the 2% target of private R&D investments may be detected and BERD remains low by international standards in particular in terms of proportion of national GDP, but also in terms of per capita. The adoption of the 3% target has been frequently debated and it is official government policy that it is unrealistic in the short and middle term, and that policies should be less focused on the GDP target, and be supplemented with additional targets for public and private R&D expenditures. In the white paper “Climate for Research” (Report to the Storting nr. 30 (2008-2009)) the government relaxed their focus on this target, and suggested this indicator should be complemented by several other targets, including R&D full-time equivalents.

As a means to increase private research spending a tax incentive scheme (Skattefunn) was introduced in 2001. It targets, and is mainly used by small companies which account for a small share of overall BERD; the success of scheme has not had much effect on the overall private share of national R&D. Indeed, Norway saw this share drop slightly from 45 in 2007 to 43% in 2009 (NIFU, 2011). Indirect government funding through tax incentives amounted to about 0.04% of GDP in Norway in 2008 (OECD, 2010). In comparison, the rates for this form of support were 0.05% for the US and Australia, 0.06% for Denmark, and 0.12, 0.19 and 0.22% for Japan, Korea, and Canada respectively. Many EU countries do not provide this form of support.

Core funding constitutes a relatively high share of the funding of research within HEIs. In 2009, the share was 2/3 of total R&D costs (NIFU, 2010). The ratio between core funding and competitive funding has remained largely constant. However, changes in the structure of core funds indicate a shift to more emphasis on performance- and strategy-based core funding of research by HEIs. The relatively minor part of HEIs’ core funding based on research performance, i.e., academic publications and competitive research funding, seem to be part of the explanation of a significant increase during the second half of the 2000s in publication output by HEI staff.

R&D by research institutes both in the government and business sectors is to an increasing extent funded as commissioned research and research-based services, while the share of core funding has decreased. A common overall framework for governmental core funding of institutes has been in place since 1993, and was amended on several key points early in 2009. The new funding structure is presently under evaluation and will be taken up for reconsideration in the 2013 White paper on research.

The Research Council of Norway (RCN) is the major source for "bottom-up", responsive-mode funding of basic research. A strong pressure by universities on the Council and the Government to increase responsive mode funding met with success in the 2011 and 2012 budgets.

One major change takes place in 2012 in funding for research. The Fund for Research and Innovation that was established in 1999 to support long term, basic research, and had a total capital of €10b (80b NOK) in 2011 is disbanded in 2012.

The returns from the Fund have been handled as a quasi-separate budget item controlled by the Ministry of Research and Education, and has provided welcome fresh resources for cross-cutting priorities within the strongly sectorised Norwegian research policy system. The abolition of this budgetary innovation and the return to normal budget procedures indicate, then, a risk that the budgetary basis for implementing cross-cutting research policy priorities may again wane. (NIFU, 2011)

Table 1: Basic indicators for R&D investments in Norway

	2008	2009	2010	EU average 2010
GDP growth rate	0,7	-1,7	0,3	2.0
GERD as % of GDP	1,64	1,8	1.69	2.0
GERD per capita	1 057,7	1 022,6	:	490.2
GBAORD (€ million)	2 249,62	2 313,321	2 649,176	92,729.05
GBAORD as % of GDP	0,74	0,85	0,84	0,76
BERD (€ million)	2 702,871	2 581,865	:	151,125.56
BERD as % of GDP	0,88	0,95	0.73:	1,23
GERD financed by abroad as % of total GERD	0,14*	:	:	N/A[3]
R&D performed by HEIs (% of GERD)	31,5	31,5	32.3	24.2
R&D performed by PROs (% of GERD)	:	:	:	13,2
R&D performed by Business Enterprise sector (as % of GERD)	53,9	52,6	:	61,5

Source: Eurostat

3.3 Evolution and analysis of the policy mixes

Arguably, Norway has, in general terms, a well-balanced and efficient set of R&D and innovation policies, as was the overall conclusion in the OECD report published in 2008 on the Norwegian innovation system.

The Barcelona R&D intensity objective that was adopted in 2005 is still operational as a long term goal for Norwegian R&D investments. However, focus has in recent years increasingly been directed towards the results of research and how research benefits society. This is reflected in the emphasis in current research policies on addressing global and societal challenges in areas such as the environment, climate, energy, and health.

The exception to the general picture during the last years of Norwegian research and innovation policy as characterised by few new initiatives, low growth and marginal changes in priorities, is the so-called “climate agreement” in 2008 between virtual all political parties. Part of the agreement was a decision to increase appropriations for

[3] 8.4 (2009), 9.04 (2005)

clean energy R&D by 75 m € within 2010. The decision was implemented, and this large growth in appropriations for R&D for the environment, climate and energy led, inter alia, to the introduction in 2008 of a programme for Centres for Environment-friendly Energy Research (CEER) administered by the Research Council of Norway (RCN). The objective of the programme is to promote high-quality research that can contribute to the development of practical solutions to environmental challenges. After the initial establishment of eight centres in 2009, 2011 saw the establishment of another three centres bringing the total number up to 11. In addition, other existing measures in support of renewable energies (RENERGI) and climate (CLIMIT) have benefited from the increased public appropriations that came as a consequence of the climate agreement (TrendChart Mini Country Report, 2011).

A key policy measure when it comes to realising national research political priorities is the large-scale programmes run by the Research Council. These programmes target specific strategic industries or thematic priorities with the aim to promote long-term knowledge development that can contribute to innovation and value-creation or to solving societal challenges. To exemplify the size of these large sectoral programmes, the Aquaculture programme (HAVBRUK) amounted to about €21 m, while that for RENERGI was € 45.4 m in 2010. Some of these large programmes were created and/or benefited from the establishment in 1999 of a Research and Innovation Fund. The effects of the disbandment of the Fund in 2012 are uncertain (see below). The INNO-Policy TrendChart Innovation Policy Progress Report for 2009 states that the Norwegian policy mix addresses “all aspects of innovation including development/prototype creation, diffusion of technology in enterprises, applied industrial research, awareness-raising amongst firms about innovation as well as other aspects.” The most important innovation policy measures, according to the report, include the tax deduction scheme SkatteFUNN as well as the programmes for User-driven research-based innovation (BIA), public and industrial R&D contracts (IFU/OFU), Centres for research based innovation (CRI), and Norwegian Centres of Expertise (NCE) (INNO-PolicyTrendChart Innovation Policy Progress Report Norway, 2009).

SkatteFUNN offers tax deductions for industrial R&D, and the scheme has gained strong popularity among industrial stakeholders since it was established in 2004. The BIA programme, which is one of the largest RCN programmes, supports R&D projects based on the needs of companies. While the SkatteFUNN is mainly used by SMEs, the BIA scheme is to a large extent designed for and mainly used by larger, more R&D-intensive companies. The IFU/OFU programme, administered by Innovation Norway, offers support to SMEs that engage in formal R&D cooperation with industrial or public actors. Recent valuations of BIA and IFU/OFU have overall been positive, and both programmes have seen some increases in annual appropriations over the recent period (INNO-Policy TrendChart Innovation Policy Progress Report Norway 2009; TrendChart Mini Country report, 2011).

The CRI and NCE programmes are both aimed at promoting industrial innovation by supporting cooperation between companies and research institutions. A key difference is that NCE programme explicitly targets the most dynamic and internationally-oriented industrial clusters in Norway.

The CRI and NCE programmes are part of what may be seen as *the* major policy innovation in Norwegian research and innovation policy during the 2000s, viz. the establishment of four major centre schemes. This includes, in addition to the two above-mentioned schemes, the Centres of Excellence (CoE) programme - for supporting large-scale, cutting-edge basic research - and the Centres for

Environment-friendly Energy Research programme (CEER). The basic idea is that centre formation contributes to critical mass, excellence, and competitiveness. All centre-based programmes are modelled on foreign examples and forerunners, and in line with general international trends.

The TrendChart Mini Country Report for 2011 gives an overview of the policy measures that have been introduced since mid-2009. The most important new measure is the Regional Research Funds that aim to to promote innovation and industrial development at the regional level by fostering R&D within regional priority areas. Seven funds covering seven regions have been operative from 2010. They are administered by regional authorities in cooperation with the Research Council of Norway, and each fund incorporates the strategic priorities of the counties belonging to the region the fund covers. Two other new measures - Young Entrepreneur (*Ung gründer*) and a scheme organised by the Ministry of Education and Research – were introduced in 2010 to promote competence development and entrepreneurship education in universities and university colleges. (TrendChart Mini Country Report Norway, 2011)

While some new measures have been established during the last year, two key measures have also been removed, causing in both cases much controversy. In the National budget for 2012 that was presented to Parliament in the autumn of 2011, the government proposed to close down the Fund for Research and Innovation (see 3.2). The 2012 budget also saw the disbandment of the so-called gift enhancement scheme by which the State tops private financial donations for basic research with 25 per cent of the private gift.

Based on the Innovation Union self-assessment tool, the high importance attached to R&D and innovation can be defined as a basic strength of the Norwegian policy mix. Education, research, and innovation are assigned a key role in the promotion of welfare and value creation, and hold centre-stage when it comes to addressing major societal challenges in areas such as the environment and health. Fostering R&D and innovation is the responsibility of several government ministries, and there is broad recognition that efforts within different policy domains must be integrated into a coherent policy framework.

Even though Norway has nominally adopted a holistic approach to R&D and innovation policy, lack of efficient coordination has been identified as a weakness. The strongly sectorally-oriented funding system limits the scope for coordinating allocations to research and innovation. This was one of the observations in the 2008 OECD review of Norwegian innovation policy, which recommended “changes in the governance of the innovation system (…) to facilitate prioritisation and efficient delivery of co-ordinated policies” (TrendChart Country Mini Report Norway, 2011; OECD, 2008). Recurrent criticisms are also voiced against what is perceived as too detailed earmarking by individual ministries of funds distributed through the Research Council of Norway and Innovation Norway.

3.4 Assessment of the policy mix

A point of departure for assessing the Norwegian policy mix is, inter alia, the comprehensive evaluation by the OECD in 2008, which concluded that Norway has a well-balanced and efficient set of R&D and innovation policies. Evaluations with generally positive conclusions of major policy instruments, such as, among many others, the SkatteFUNN scheme, the IFU/OFU scheme, and various centre schemes at different stages in their development, indicate that these instruments are generally

effective and well managed. As a consequence of the highly sectorised system both in R&D and innovation policies, the policy mix is, however, complex and in regular need of simplification and alignment. The organisational simplification at the intermediate, strategic level through the merger of previous research councils and organisations for innovation and industry support has not resolved these issues, partly due to the undiminished role of the sector principle at the governmental/political level. As the issue is hardly addressed at the governmental level, it remains to a high extent assessed as an issue for intra-organisational coordination and simplification within, in particular, the Research Council of Norway and Innovation Norway. The complexity of the system is also due to the fact that the policy mix has developed by layers of new instruments being put on top of extant instruments, which are rarely disbanded altogether.

The Research Council of Norway significantly reorganized itself during 2011 into 4 divisions. As a result, the division for innovation has targeted closer linkages between research and industry. It also evaluated the effectiveness of some of its large programmes in this light. The Research Council of Norway is currently under assessment by a team of external evaluators.

Innovation Norway and SIVA were also the objects of formal evaluations in 2011, and the Ministry of Trade and Industry has recently a follow-up in ten form of White paper, which, inter alia, proposes to simplify the goal structure of Innovation Norway, but leave in place its many instruments (targeting agriculture) that have been widely criticized as of little import for innovativeness.

A characteristic feature of both R&D and innovation policies since the turn of the decade is their relative stability and continuity, with some innovations but no radical shifts. Appropriations for R&D have increased considerably, particularly in the second half of the 2000s.

A prerequisite for innovation, value creation and growth is sufficient supply of human resources, and engineers in science and technology are perceived to be essential for future growth in new knowledge intensive sectors. The government has focused on the low levels of S&T graduates for a number of years and the issue is pervasive in policy debates and documents. While there has been an increase in the number of S&T graduates in recent years, Norway continues to lag behind other European countries.

Norway has a number of policy measures whose objective is to support R&D in companies. The overall public support for industrial R&D is relatively high in Norway, and the mix of instruments has remained largely stable for at least a decade. The latest innovation was the introduction of tax the tax deduction scheme SkatteFUNN in 2002. The evaluation of the scheme published in 2008 points to the effectiveness of the measure in terms of leveraging more R&D activity in small businesses with low R&D intensity. However, targeting SMBs, the scheme has not had, and could not in itself have, much effect on overall BERD, which is for the largest part by far performed by large companies. Instruments targeting these companies, e.g., the BIA scheme has remained stable, if reorganised and “de-sectorised”.

Despite these measures -which are all generally recognised as being appropriate and effective - private R&D spending remains low compared to other European countries. This indicates that the objective to increase industrial R&D expenditure cannot be achieved without comprehensive, structural changes in the Norwegian economy. Hence, the issue of the level of private investments in R&D must partly be

reframed as an issue of what developments in industrial structure proves to be viable in the longer term.

A possible new approach to sustain long-term competitiveness and stimulate diversification may be to consider policy measures which target the build-up of industrial R&D capacity and complementary competences in new technological areas, by means of stimulating intramural R&D and linkages to partners abroad besides, or even at the expense of, measures which focus on reinforcing already strong linkages between large, incumbent firms and the public research base. (Herstad, Bloch, Ebersberger & van De Velde, 2010) The current system of research funding appear in this perspective excessively geared towards supporting R&D conducted by research institutes on behalf of incumbent industrial firms, as a basis for continued growth along the current technological development path, rather R&D conducted by new industrial firms which deviate from it and thus are more dependent on internal capacity build-up.

Stimulating graduates to undertake S&T subjects and increasing R&D activity in private business is, however, crucial for the ability of the Norwegian economy to remain innovative and competitive in all future scenarios of the Norwegian economy. Another important factor is to support new knowledge-based start-up companies in the growth and commercialisation phase. This support is foremost provided through traditional schemes such as grant schemes for start-ups, investments funds, science parks, business gardens and knowledge parks.

These supply-oriented measures are accompanied by more horizontal and/or demand-side policies. Recent strategies for research and innovation strongly emphasises the need the focus on specific sectors of strength in the Norwegian economy. There is a broad consensus that public investments in research related to climate change, environment and sustainable energy should be increased. Policy strategies have been followed up by increased funding of these priority areas and new instruments, notably the Centres for environment friendly energy research (FME) that were launched in 2009. In 2012 new regulations and green electricity certificates will be implemented to stimulate new investments in sustainable energy. The policy orientation towards these sectors is relatively new and it remains to be seen if policy action and measures will prove appropriate to tackle the structural challenge of restructuring the economy.

Table 2: Assessment of the policy mix in Norway

Challenges	Policy measures/actions[4]	Assessment in terms of appropriateness, efficiency and effectiveness
Shortage of science and engineering graduates	Strategy for a Joint Promotion of Mathematics, Science and Technology; Industry PhD scheme.	Since long Norwegian policymakers have addressed the challenge of an insufficient number of science and engineering graduates. Initiatives, such as awareness companies and a persistent policy attention on the issues seem to have led to increased interest to choose S&T subjects amongst students. It is however being recognized that the measures are have not been effective enough.

4 Changes in the legislation and other initiatives not necessarily related with funding are also included.

Challenges	Policy measures/actions[4]	Assessment in terms of appropriateness, efficiency and effectiveness
Progress towards reaching the R&D intensity, especially for private R&D expenditures	R&D tax credit scheme; Grant scheme for start- ups; State Investment Fund; science parks; knowledge parks; business gardens, renewed programme for commercialisation of research results (FORNY2020).	The SkatteFUNN scheme is most effective for small businesses, in companies where education levels among the workforce are relatively low, and in companies with low R&D intensity. The scheme has, however, not prevented the share of total R&D funding by domestic firms from declining.
Restructuring of the economy	Increased funding to environmentally friendly energy research, establishment of new Centres for environmentally friendly energy research (FME), introduction of green electricity certificates.	The political consensus about the economic sectors that can contribute to reorient the economy towards a more knowledge intensive economy may be seen as effective for long term commitment on public investments in research and innovation and ensure predictability for industry and researchers. A problem that remains is the institutional path-dependency around the oil and gas sector that would imply an imbalance between allocations of resources to emerging sector.

In light of the consensus in Norway about policy challenges, several areas of the Norwegian system are currently being evaluated. The policy mix of the system is currently under assessment, in large part as part of preparations for the next White paper on research which the Ministry of Research and Education will present in spring 2013. The focus is specifically on improving the effectiveness of RDI investments, on stimulating better flows of knowledge and competencies, and on encouraging a greater internationalisation of the system. This work is complemented by developments in other RDI policy areas. The Ministry of Trade and Industry is also focusing on the role and use of Intellectual Property Rights in Norway. In light of consistently unfavourable international comparisons of Norwegian IPR use and of the relatively recent transition to the European Patent Convention, it began work on a White Paper on IPR system and its use in Norway. Another more indirect area that is currently being assessed is the education system, where an ongoing evaluation of a recent reform in the school curricula (Kunnskapsløftet), is due in 2012.

4 National policy and the European perspective

In general, the Norwegian policy mix can be said to be well aligned with the ERA pillars and objectives. Aligning national priorities with EU policy objectives is an explicit policy of the Norwegian government, as set out in several recent policy documents.

Norway has not implemented the EU recommendations on a Scientific Visa. However, in January 2010 a new Immigration Act came into force in Norway which simplifies registration procedures for EU/EEA/EFTA nationals and makes it easier for skilled workers from countries outside the EU/EEA/EFTA to apply for employment in Norway.

Increased cross-border cooperation in research is a key objective in Norwegian research policy, as illustrated e.g. by the 2011 launch of a Research Council Strategy for internationalisation. Yet, the behavioural additionality of current funding schemes in this context, and thus extent to which research policy manages to balance effectively between domestic and international initiatives remains as questionable in Norway as in most other European economies (see Ebersberger, Herstad, Iversen, Som & Kirner, 2011).The situation is currently that applicants from abroad must as a rule have a formal affiliation with a Norwegian institution to be eligible for Norwegian funding. However, some funding opportunities, programmes, grants and scholarships are specifically designed for foreign researchers and partners. Normally, applications for funding under the Research Council's research programmes and other funding opportunities are only accepted from Norwegian institutions and companies.

Norway is actively participating in cross-border cooperation programmes initiated by the EU, such as ERA- Nets, JPI, art.185 initiatives and JTIs. Important cross- border cooperation is also taking place within the formalized Nordic cooperation framework under the auspices of the Nordic Council of Ministers. In this context a noteworthy activity is the joint programming imitative, the Top-level research initiative launched in 2009. In this programme the Nordic countries pool resources according to a common pot funding model with the objective to fund research in the fields related to energy, environment and climate.

Table 3: Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA dimension	Main challenges at national level	Recent policy changes
1	**Labour Market for Researchers**	Maintain the internationally attractiveness of Centres of Excellence. Increase the share of grantees who finish their doctoral studies within the prescribed time frame. Reduce the share of short time temporary researcher positions and support the institutions' responsibility for career advice and opportunities. Norway has not implemented the EU recommendations on a Scientific Visa.	Government strategy to reduce the number of temporary contracts in the higher education sector.
2	**Cross-border cooperation**	Open up the research system to foreign researchers. Currently applicants from abroad must as a rule have a formal affiliation with a Norwegian institution to be eligible to seek Norwegian funding.	Participation in joint programming initiatives (JPI) (healthy oceans) and a large number of ERA NETs. Launch of the Nordic top-level research initiative in 2009 based on common pot funding.

	ERA dimension	Main challenges at national level	Recent policy changes
3	**World class research infrastructures**	Ensure adequate recruitment of new researchers and promote Norway as an attractive partner for international research cooperation. Make it attractive for international companies to conduct their research in Norway.	Updated roadmap on RI in 2010. In October 2010 the Norwegian Social Science Data Services AS (NSD) in Bergen was chosen as host to the database cooperation project Council of European Social Science Data Archives.
4	**Research institutions**	Hesitant long-term structural reform policies for the HEI sector.	A new university established in January 2011. Government financial support for formal HEI cooperation in 2010 and 2011.
5	**Public-private partnerships**	:	The Regional Research Funds launched in early 2010 have the aim to improve cross-sectoral cooperation and boost regional research. Norwegian participation in JTIs ARTEMIS and ENIAC.
6	**Knowledge circulation across Europe**	Potential for increased participation in EU framework programmes. Low success rate in relation to contribution of funds for participation.	Launching of the joint programming initiative (JPI) for *clean seas and oceans*.
7	**International Cooperation**	:	Launching of a new joint programmes with China and India in 2010.

Annex: Alignment of national policies with ERA pillars / objectives

1. Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers

1.1 Supply of human resources for research

In 2009, 64,000 persons (headcounts) participated in R&D activity in Norway; nearly 45,000 of these were researchers, while approximately 19 000 were in technical or administrative positions. The number of R&D personnel increased with in total 1000 persons, from 2008 (NIFU, 2011).

As is shown in Table 9 the share of researchers of the total active population is substantially higher in Norway compared to the EU-27. This is true also when considering the different sectors.

Table 2: Total number of researchers by sector of performance, as percentage of active population- number in head count in 2007

	Business enterprise	Government	HEI	All sectors
EU-27	0.32	0.1	0.48	0.91
Norway	0.66	0.22	0.79	1.67

Source: Eurostat

At the end of November 2008 the unemployment rate for Norwegian employees with a higher education (five years or more) was 0.7%. For employees with lower levels of education the unemployment rate was 0.8%. Although the last financial crisis has led to increased unemployment among the more highly educated, the unemployment rate remains relatively low (NIFU STEP, 2010).

Data on the numbers and flows of researchers into and out of Norway are limited.[5]

The number of researchers in Norway with foreign citizenship has increased in recent decades. In 2007, foreign citizens accounted for 13% of the total number of researchers, up from nine % in 1997.The highest number of foreign researchers in Norway came from Germany, followed by Sweden, Denmark, Great Britain and the USA. Amongst non-western countries China and Russia had the highest number of researchers registered in Norway (NIFU, 2011).

The share of foreign doctoral graduates has increased, from 10% in the early 1990s to 20-25% in the last five years. The total number of doctoral degrees awarded to non-nationals was 293 out on a total of 1,184 in 2009. The share of foreign doctoral graduates is highest in the natural and technological science and in agriculture (NIFU STEP, 2010).

1.2 Ensure that researchers across the EU benefit from open recruitment, adequate training, attractive career prospects and working conditions and barriers to cross-border mobility are removed

Enhancing the training skills and experience of researchers is a priority in Norway. The government white paper emphasized the need for strengthening the leadership and research administration skills of researchers.

Doctoral programmes are offered by all university-level institutions, some state university colleges and a few private institutions. PhD courses are increasingly being offered in English.

[5] The MORE project only includes EU-27 countries.

As part of the Quality Reform of Higher Education in Norway introduced in 2003, the number of doctoral titles (previously 14) has been reduced to just two. Research courses now lead to a PhD, corresponding to the Anglo-American degree system.

Since 2004, the Norwegian Centre for International Cooperation in Higher Education (SIU) under the Norwegian Ministry of Education and Research has promoted and facilitated cooperation, common accreditation standards and standardisation of degrees, mobility and the lowering of cultural barriers hampering student and researcher mobility.

Further, the Norwegian ENIC-NARIC centre NOKUT (the Norwegian Agency for Quality Assurance in Education) considers applications for general recognition of foreign qualifications. The agency is also responsible for providing foreign institutions and partners with information about the Norwegian educational system and the procedures for recognition of foreign higher education qualifications.

To increase training and skills in industry PhD fellows are awarded by the RCN under the user-driven innovation programmes. The Industrial Ph.D. scheme gives companies the opportunity to enhance their research expertise without having to participate in a more comprehensive project (User-driven Innovation Project or Knowledge-building Project with User Involvement). About €7.7m (NOK60m) has been set aside for the Industrial Phd scheme in 2010 (Ministry of Finance, 2010).

As to providing adequate social security coverage for all publicly funded researchers receiving stipends and fellowships, the situation in Norway is very good. In Norway publicly funded researchers including PhD students have employment contracts and receive adequate social coverage. In Norway the PhD students from third countries which receive grants over the budget for development cooperation however have status as students and social coverage as students.

As to “portability of individual grants awarded by national funding agencies”, there is still room for action by Norwegian policymakers. Nevertheless, an example of good practice is the portability of grants between the United Kingdom and Norway and Norway and Austria. On the portability of grants, Norway is amongst those countries having signed EUROHORC’s letter of intent “Money follows researchers” (SGHRM, 2009).

As to access to information, Norway has posted information on the transferability of social security and supplementary pension rights on its national websites and on EURAXESS. There are no barriers to for non-nationals in competitions for permanent research and academic positions.

Norway has not implemented the EU recommendations on a Scientific Visa. However, from 1st January 2010 a new Immigration Act came into force in Norway. The new Act simplifies registration procedures for EU/EEA/EFTA nationals and makes it easier for skilled workers from countries outside the EU/EEA/EFTA to apply for employment in Norway.

1.3 Improve young people's scientific education and increase interest in research careers

The number of new S&E graduates is far below the EU-average. The government has focussed on this challenge for a number of years, and the issue is pervasive in policy debates and documents. S&E fields are inter alia strongly prioritised in the distribution of new positions for PhD students. Several measures are targeted at the position of scientific and technological subjects in secondary education. They are parts of a “Strategy for a Joint Promotion of Mathematics, Science and Technology” (“Et felles løft for realfagene”) which has been in operation and continually updated since 2002. The quality of teaching and qualifications of teachers is recognised as a core issue. Students’ interest for S&T subjects and careers has, in particular at the secondary level, apparently increased as a consequence of these campaigns and increasingly more pervasive attention to the issue. Several aspects of the challenge are taken up in recent white papers on teachers’ education and competence and education for work life.

During the last decade a growing interest and awareness may be seen amongst policymakers in Norway about the importance to fostering individuals’ creative and innovative abilities for future economic growth and value creation in the country. As in many other countries in Europe, focus has increasingly been placed on the importance of entrepreneurship and innovation skills. Since early 1990 the Ministry of Education has stimulated entrepreneurship education (EE) at all levels of the educational system. Government strategies for innovation policy emphasise creativity and innovation by means of introducing entrepreneurial skills in higher education.

An inter-ministerial strategy for entrepreneurship in education 2004-2008 was published as a joint endeavour by the Ministries of Education and Research, Trade and Industry, and Local Government and Regional Development. The starting point of this strategy is enhanced culture for creativity and innovation is necessary to promote entrepreneurship. It is further recognised that innovative skills are important to maintain sustainable local communities across the country.

The Norwegian Entrepreneurship Programme (Gründerskolen) was established by the University of Oslo in 1999. Today the programme is a joint cooperation between Innovation Norway, Oslo University's School of Entrepreneurship and Rice University's Centre for Entrepreneurship.

Another important measure is the industry PhD scheme, established in 2008. The goal of the scheme is to increase research activities in companies and strengthen knowledge exchange between industry and academia.

In 2010, two programmes were introduced to deal with competence development and entrepreneurship education in universities and university colleges: a) "Young Entrepreneur" (*Ung gründer*) organised by Innovation Norway to stimulate the regional university colleges to develop programmes for students' entrepreneurship; b) A scheme organised by the Ministry of Education and Research for competence development in universities and regional university colleges for further development of entrepreneurship and innovation programmes.

1.4 Promote equal treatment for women and men in research

In Norway, proactive policies and practices aiming at achieving adequate (40%) gender representation in selection and funding bodies are in place. All higher education institutions have action plans for gender balance. A national "Women in Science" committee and website was established in 2004 and an annual national quality award to institution with the best gender equality initiatives was established in 2007. The latest white paper (2008-2009) on research policies is focusing on how to improve the gender balance at all researcher levels and in all scientific fields including those with low female participation, such as in natural science and technology (SGHRM, 2009). Career breaks, such as parental leave do not in general penalise researchers. After parental leave the restoration to the same position is guaranteed by law.

2. Facilitate cross-border cooperation, enhance merit-based competition and increase European coordination and integration of research funding[6]

Norway participates in a range of international collaborative efforts concerning education and research. Internationalisation of Norwegian research has been a top priority in research policy for a long time. This is manifest in official documents that outline public research policy such as the White Paper on research policy presented to the Norwegian parliament (Stortinget). The rational for participating emerges from the 2009 White Paper on research policy: “Internationalisation of research is important in order to increase quality and strengthen relevance of Norwegian research and in order to provide us with access to research done outside of Norway”.

Norway participates in approximately 40 ERANETs mostly though the RCN Norwegian participation in ERA NETs is notable especially in the area of industrial technology, ICT, space, innovation and transport, but also within environment and energy. ERANETs with Norwegian participation have received a total funding of €96.3m, with close to €8.7m to Norwegian participants (Ministry of Education and Research, 2008).

6 Promote more critical mass and more strategic, focussed, efficient and effective European research via improved cooperation and coordination between public research funding authorities across Europe, including joint programming, jointly funded activities and common foresight.

- Ensure the development of research systems and programmes across the Union in a more simple and coherent manner.
- Promote increased European-wide competition and access of cross-border projects to national projects funding

Norwegian participation in art. 185 initiatives is à la carte depending on the national interest of the programme. Norway currently participates to the following art. 185 actions:

- *Developing Countries Clinical Trials Partnership* (EDCTP) through a specific cooperation agreement. Norwegian co-funding is available from the RCN under specific conditions.
- *Ambient Assisted Living* (AAL) and
- *EUROSTARS*.

Norwegian funding is managed through the Research Council of Norway under national rules.

Together with Belgium and Spain, Norway has initiated the JPI for *Health and Productive Seas and Oceans.* This JPI seeks to create an integrated knowledge base that enables an integrated policy to make the most of marine resources in a sustainable way, while understanding and mitigating the impact of climate change on the marine environment and coastal areas. Norway has expressed interest in participate in all JPIs. Norway participates in the following JPIs:

- *A healthy diet for a health life*
- *Agriculture, food security and climate change*
- *Neurodegenerative Disease/Alzheimer's*
- *Climate knowledge for Europe (CliK'EU)*

3. Develop world-class research infrastructures (including e-infrastructures) and ensure access to them

The government white paper on research, *Climate for Research*, assigns the Research Council the responsibility for drawing up a Norwegian roadmap for investment in research infrastructure. The Roadmap is to present national and international large-scale projects in which the Research Council recommends investing in the near future – within a realistic budget framework. The white paper stipulates that research infrastructure investments to be included on the Roadmap must be selected on the basis of stringent criteria in terms of quality as well as relevance and benefit to society.

The Norwegian Roadmap corresponds closely to similar national roadmaps that have been, or are being, drawn up in many other European countries. The Norwegian Roadmap is a direct follow-up of the Government white paper on research, Climate for Research, and is closely linked to the National Financing Initiative for Research Infrastructure which had its first call for proposals in 2009.

The roadmap will be updated after each major announcement of funding for research infrastructure, the first time in mid-2011 (Research Council of Norway, 2010).

The Norwegian roadmap 2010 includes projects on the European Roadmap for Research Infrastructures in which Norway has entered into binding agreements or has clearly signalled its desire to participate. Norwegian research groups are participating in the preparatory phase for six projects. All the projects have undergone a thorough review by ESFRI and are also considered to be of major strategic importance for Norwegian research. None of the projects had come far enough in their planning process for the Norwegian research groups to seek funding from the Research Council in the first funding round under the National Financing Initiative for Research Infrastructure (in 2009).

Projects on the European Roadmap for Research Infrastructures in which Norway has entered into binding agreements or has clearly signalled its desire to participate are shown in Table 10. These include five large scale facilities and one scientific database.

In October 2010 the Norwegian Social Science Data Services AS (NSD) in Bergen was chosen as host to the database cooperation project Council of European Social Science Data Archives (CESSDA RI).

Table 3: ESFRI facilities. Source: RCN, 2010.

Project	Topic	Norway offers hosting	Participating Norwegian institutions
SIOS: The Svalbard Integrated Arctic Earth Observing System	Climate and Environment	yes	RCN, NPI, UNIS, NSC, UiB, UiT, METNO, NERSC, IMR, NILU, NMA, ARR
ESRF: Upgrade European Synchrotron Radiation Facility*	Materials Science	No	NordSync (Norway, Sweden, Denmark, Finland)
ECCSEL :European Carbon Dioxide Capture and Storage Laboratory Infrastructure	Carbon Capture and Storage, Energy	yes	NTNU, SINTEF
ESS: European Spallation Source	Physics, Materials Science	No	IFE, NTNU, UiO, UiB
EISCAT-3D:Next Generation European Incoherent Scatter Radar System*	Physics, Space Research	No	UiT, UNIS, UiO, UiB og FFI
CESSDA: Council of European Social Science Data Archives	Social Sciences	yes	Norwegian Social Science Data Services (NSD)

**Norway is member of ESRF and EISCAT*

4. Strengthen research institutions, including notably universities

Pervasive reforms are being implemented in the HEI sector following the comprehensive "Quality Reform" that took place on the basis of a 2001 white paper. New laws have been passed on higher education, and fundamental changes have, under the auspices of the Bologna process, been made to the programme structure of higher education. HEI institutions have been accorded more extensive institutional autonomy and the funding of both teaching and research in HEIs has progressively become more performance based.

Changes to the structure of institutional governance have also been part of the Quality Reform. Traditionally the management of tertiary institutions in Norway has been a divided responsibility between a rector elected for a four-year term who is responsible for academic matters, and a general director, appointed by the board of the institution who heads the administration. The new law on higher education passed by the parliament in spring 2005, contained provisions allowing for a choice between the traditional model and a model in which the board is chaired by an external member, with the rector appointed by the board and responsible for both academic and administrative matters. Greater institutional autonomy in financial matters has been encouraged in recent years (for example by allowing institutions to retain financial surpluses), as have moves towards a more managerialist, rather than collegiate, approach to internal management structures (OECD, 2006).

Universities have the possibility to make decisions for allocating resources autonomously in line with their research priorities. In general terms, evidence indicates inadequate management and weak strategic direction of institutional policies for research.

About 80% of public funds for R&D in HEIs are channelled directly from the Ministry of Education and Research to the institutions, almost all of which is institutional funding. Since 2003 a funding structure has been in place for these funds, which consists of three core components:

- basic funds which are block funding without detailed specifications of their use. This component initially amounted to about 60% of institutional funding (on average for all HEI institutions), but has decreased somewhat;
- a teaching component, in which funds are distributed on the basis of reported student performance; this component initially amounted to about one-quarter of institutional funding and has increased somewhat;
- a research component, which amounts to about 15% of institutional funding. This component is subdivided into two parts:
    1. a performance-based part, within which funds are redistributed among institutions on the basis of benchmarks for publications and competitive research funding, and
    2. a strategic component, within which earmarked funds are allocated to specific institutions for positions for PhD students and for scientific equipment.

An elaborate system for registering and reporting input to the performance-based parts of the system has been developed. NOKUT – the Norwegian Agency for Quality Assurance in Education – is an independent government agency that contributes towards quality assurance and enhancement in higher education and tertiary vocational education. NOKUT conducts quality controls and stimulates the quality development of educational provision at Norwegian universities, higher education colleges and colleges of tertiary vocational education.

The higher education sector received most of its R&D funding from Norway's General University Funds (GUF). GUF funding amounted to 65% of total R&D spending in the sector in 2007. This share has remained stable since 2003, after declining from 70% in the late 1990s. Other funding sources have thus increased from about 30-35% in the last ten years (Source: Report on Science and Technology Indicators for Norway 2009, NIFU STEP).

5. Facilitate partnerships and productive interactions between research institutions and the private sector

Unemployment among graduates with higher degrees has been very low in recent years. At the end of November 2008 the unemployment rate among those with at least five years of university education was 0.7%. The financial crisis has led to increased unemployment among highly educated employees, although less than the national average.

In Norway most doctoral candidates are employed in the public sector. However, a large minority – just under 40% – work in the private sector, including research institutions. Almost half of the private sector workforce that hold doctoral degrees are employed at research institutions or R&D companies; one in four works in a service company, one in six in a manufacturing company, and one out of ten in oil and gas activities. Two thirds of public-sector employees with doctoral degrees work at universities and colleges, while a quarter work in the country's health institutions.

The creation of new ventures based on academic research, or academic entrepreneurship, has become an objective for policy makers and universities across Europe. In line with the international trends, the FORNY programme was established during the 1990s and is the main support mechanism for commercialisation of public funded research in Norway. The FORNY programme run by the RCN is the most important measure for supporting the commercialisation of R&D results. While the budget was €5.6m (NOK44m) in 2000, it has been tripled up to about €16.6m (NOK130m) in 2008.

On average, the programme has approved around 50 commercialisations per year since 2001; however, the number has varied considerably (see figure 2). While 50 commercialisations were approved in 2001,

there was a falling tendency until 2003, and later there has been a significant growth up to the estimated 70 approved commercialisations in 2008.

According to an evaluation of the FORNY programme from 2009 the spin-off firms established as a result of the programme are placed within knowledge intensive industries. Spin-offs within information and communication technology are most frequent (43.7%). Then follows biotechnology and energy/environment (both 16.9%), and maritime and med-tech/biomedicine (both 15.5%). The far most important sources of the technological ideas behind the spin-offs were the research in the institutions where the spin-off was initiated (Borlaug et al. 2009).

Promoting research institutions - SME interactions

There are several policy instruments in place which facilitate interaction between research organisations and SMEs. Innovation Norway runs the "IFU/OFU" programmes, which support R&D contracts between small and medium sized enterprises (SMEs) and either larger firms or public institutions. "SkatteFUNN" is a programme operated by RCN which support R&D investments in companies. For many of the FORNY start-ups, in particular those with a significant growth potential, the seed capital funds are important to provide risk capital, thus representing a good example of policy mix complementarity.

Involvement of private sectors in the governance bodies of HEIs and PROs

Public-private knowledge transfer is ensured by the involvement of representatives from the private sector in the governance of higher education institutions. At several universities a large part of board members are external members often representing private sector.

6. Enhance knowledge circulation across Europe and beyond

There are several programmes under the Research Council of Norway (RCN) which aim to attract international researchers to Norway. The YGGDRASIL mobility programme promotes the internationalisation of Norwegian research by offering grants to highly qualified, international Ph.D. students and younger researchers in connection with research stays in Norway. The programme seeks to make Norway an attractive research destination for highly qualified international Ph.D. students and younger researchers, thus strengthening the Norwegian research communities involved at the same time.

Norway's most important multilateral agreement with other ERA countries is represented by the formalised Nordic research cooperation. The organisation of Nordic collaboration in research and innovation rests on two main pillars, one for research, (the Nordic Research Board, NordForsk), and one for innovation (Nordic Innovation). The Top-level Research Initiative (TRI) is the largest joint Nordic research and innovation initiative to date.

7. Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world

Norway participates in a range of international collaborative efforts concerning education and research. Internationalisation of Norwegian research has been a top priority in research policy for a long time. This is manifest in official documents that outline public research policy such as the White Paper on research policy presented to the Norwegian parliament (Stortinget). The rational for participating emerges from the 2009 White Paper on research policy: "Internationalisation of research is important in order to increase quality and strengthen relevance of Norwegian research and in order to provide us with access to research done outside of Norway".

The EU framework programmes are the most important international research programmes in which Norway takes part. Norwegian researchers have participated in the EU FPs since 1987.

During the first four years of FP7, Norway participated in 3 071 applications resulting in 728 projects. The 728 approved projects are expected to provide Norway with overall funds of 331 million euros. Estimates suggest this puts Norway's share at about 1.8% of all competitive funding allocated under FP7 so far.

Norway is particularly well-represented in some of the specific Framework Programme areas. Norway has the highest success rate of any of the EU member countries and associate countries in both the Energy program and SiS, and has the second highest success rate in the SME programme.

Norway participated in fewer projects for the first four years of FP7 compared with FP6, despite the fact that FP6 involved fewer (and larger) projects than FP7 so far. There is also slightly less Norwegian participation per project in FP7, compared to FP6. Furthermore the Norwegian success rate is lower in FP7 than in FP6, although part of this follows from lower average success under FP7 as a whole. While Norway has received more support in total from FP7 projects than it did in 6RP, this can partly be explained by changes in funding whereby the EU finances up to 75% of project costs in FP7, compared with 50% in FP6 (NIFU, 2011).

Table 4: Key results for Norwegian participation in FP6 and FP7. Source: E-corda /NIFU, 2011

	All programmes	
Indicator	**6RP (2003–2006)**	**7RP (2007–des 2010)**
Number of projects with Norwegian participation	849	728
Rate of success for Norwegian projects	*27.1%*	*23.7%*
Proportion of projects with norwegian participation of all cancelled projects.	*8.4%*	*6.7%*
Number of Norwegian projects	1 299	1 059
Number of Norwegian coordinators	148	170
Estimated EU funding to Norwegian particiants (NOK)	2.3 bill.	2.7 bill.
	1.7%	*1.8%*

The "*EEA and Norway grants*" supports projects in the 12 newest member states as well as in Greece, Portugal and Spain. The large majority of partnership projects within the field of research concerns protection of the environment and sustainable development. The largest number of approved projects in this sector is in the EEA and Norway Grants' largest recipient state, Poland, with 41 approved projects worth more than €42m.

Norway has signed a bilateral agreement with France (in 2008). The French Norwegian Foundation promotes long-lasting French/Norwegian cooperation through the financing of joint R&D projects in which both industry and research institutes/universities are involved with the aim of creating cooperation lasting beyond the project-period. On the Norwegian side, €375,000 (NOK3m) is allocated each year to finance the Norwegian participation in the projects.

Norway has also signed several bilateral agreements with third countries. The research cooperation with China (CHINOR programme) enables the RCN to enter into partnerships with Chinese governmental research financing bodies. The thematic priorities at start-up are climate change, climate technology, environment and welfare.

The South African-Norwegian programme for Research Cooperation has been established to continue the development of long-term and sustainable research co-operation between Norway and South Africa based on equal partnership. The aim of the programme is to achieve scientific excellence and relevance to the thematic areas. Prioritised research topics are: health and medical sciences, HIV/AIDS, Environment and Energy with emphasis on renewable and sustainable energy sources and socio-economic impacts.

Cooperation with India is achieved through the INDNOR programme launched in 2010. In the first call for proposals the energy and climate change field was prioritised.

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List of Abbreviations

AAL	Ambient Assisted Living
ARR	Andøya Rocket Range
BERD	Business Expenditure of Research and Development
BIA	User driven research based innovation programme
CCS	Carbon Capture and Storage
CEER	Centres for Environment-friendly Energy Research
CESSDA	Council of European Social Science Data Archives
Clik'EU	Climate knowledge for Europe
CO2	Carbon dioxide
CoE	Centres of Excellence
CRI	Centres for research based innovation
EDCTP	Developing Countries Clinical Trials Partnership
EE	Entrepreneurship Education
EEA	European Economic Area
EFTA	European Free Trade Association
EIT	European Institute of Technology
EPO	European Patent Office
ERA	European Research Area
ERA NET	European Research Area Network
ERC	European Research Council
ERDF	European regional development fund
ESF	European Social Funds
ESF	European Science Foundation
ESFRI	European Strategy Forum on Research Infrastructures
EU	European Union
EU-27	European Union including the 27 member states
FFI	Norwegian Defence Research Establishment
FME	Environment-friendly Energy Research
FP	European Framework Programme for Research and Technology Development
FTE	Full time Equivalent
GBAORD	Government Budget Appropriations or Outlays on Research and Development
GDP	Gross Domestic Product
GERD	Government Expenditure on R&D
GLOBVAC	Global Health and Vaccine Research
GNP	Gross National Product
GUF	General University Fund
HEI	Higher education institutions
HERD	Higher Education expenditure on R&D
HES	Higher education sector
HRST	Human Resources in Science and Technology
ICT	Information and Communication Technology
IFE	Institute for Energy Research
IMR	Institute of Marine Research
IN	Innovation Norway
IPRs	Intellectual Propert Rights

IUS	Innovation Union Scoreboard
JPI	Joint Programming Initiatives
JTIs	Joint Technology Initiatives
LO	Norwegian Confederation of trade Unions
MER	Ministry of Education and Research
METNO	The Norwegian Meteorological Institute
NCE	Norwegian Centre of Excellence
NERSC	Nansen Environmental and Remote Sensing Center
NHO	Confederation of Norwegian Enterprise
NICe	Nordic Innovation Centre
NIFU	Nordic Institute for Studies in Innovation, Research and Education
NILU	Norwegian Institute for Air Research
NMA	Norwegian Mapping Authority
NOK	Norwegian kroner
NOKUT	Norwegian Agency for Quality Assurance in Education
NPI	Norwegian Polar Institute
NSC	Norwegian Space Centre
NSD	Norwegian Social Science Data Service
NTNU	Norwegian University for Science and Technology
OECD	Organisation for Economic Cooperation and Development
PCT	Patent Cooperation Treaty
PNP	Public private partnership
PRO	Public Research Organisations
R&D	Research and development
RCN	Research Council of Norway
RDI	Research Development and Innovation
RI	Research Infrastructure
S&E	Sciences nand Engineering
S&T	Science and technology
SF	Structural Funds
SGHRM	Steering Group for Human Resources and Mobility
SIVA	The Company for Industrial Growth
SMEs	Small Business Enterprises
TRI	Top-level Research Initiative (Nordic joint programme)
TTO	Technology Transfer Office
UiB	University of Bergen
UiO	University of Oslo
UiT	University of Tromsø
UNIS	The University Centre in Svalbard
USA	United States of America

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Abstract
The main objective of the ERAWATCH Annual Country Reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. EW Country Reports 2011 identify the structural challenges faced by national innovation systems. They further analyse and assess the ability of the policy mix in place to consistently and efficiently tackle these challenges. The annex of the reports gives an overview of the latest national policy efforts towards the enhancement of European Research Area and further assess their efficiency to achieve the targets.

These reports were originally produced in November - December 2011, focusing on policy developments over the previous twelve months. The reports were produced by the ERAWATCH Network under contract to JRC-IPTS. The analytical framework and the structure of the reports have been developed by the Institute for Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) and Directorate General for Research and Innovation with contributions from ERAWATCH Network Asbl.

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