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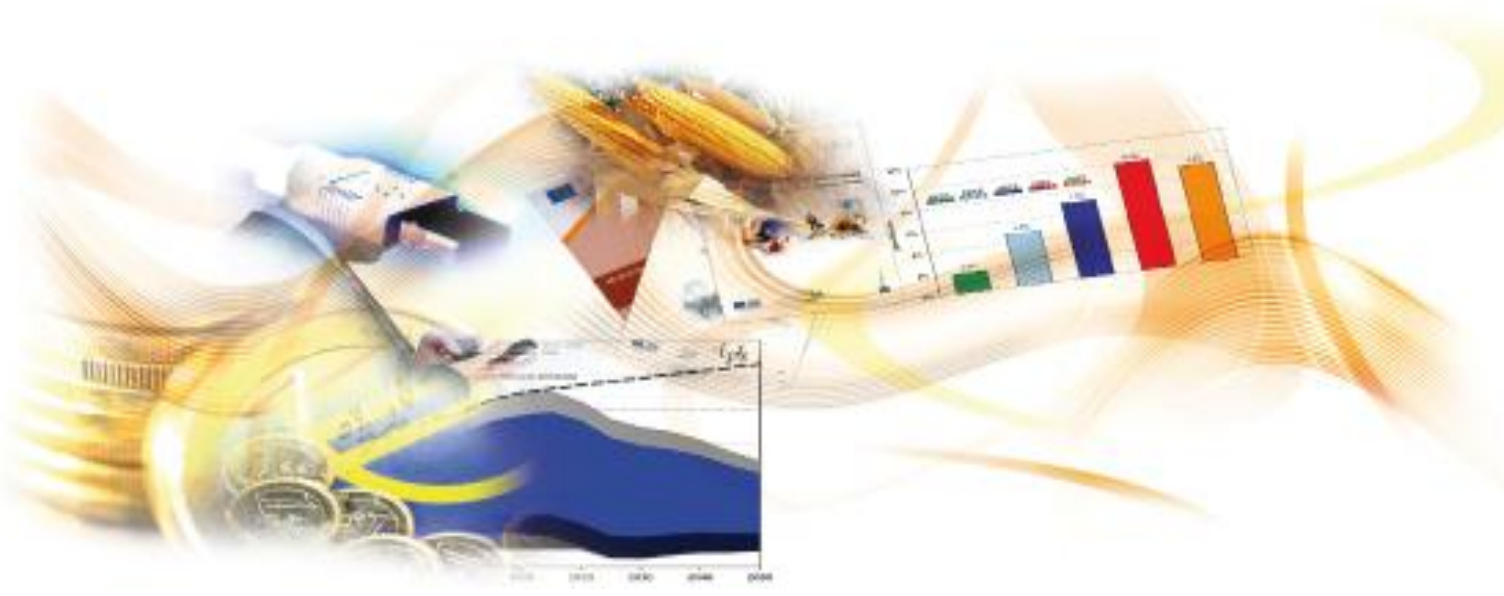

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This analytical country report is one of a series of annual ERAWATCH reports produced for EU Member States and Countries Associated to the Seventh Framework Programme for Research of the European Union (FP7). ERAWATCH is a joint initiative of the European Commission's Directorate General for Research and Innovation and Joint Research Centre.

The Country Report 2012 builds on and updates the 2011 edition. The report identifies the structural challenges of the national research and innovation system and assesses the match between the national priorities and the structural challenges**,** highlighting the latest developments, their dynamics and impact in the overall national context.

The first draft of this report was produced in December 2012 and was focused on developments taking place in the previous twelve months. In particular, it has benefited from comments and suggestions of Inger Midtkandal from JRC-IPTS who reviewed the draft report and Svein Olav Nås, from Research Council of Norway.

The report is currently only published in electronic format and is available on the ERAWATCH website. Comments on this report are welcome and should be addressed to jrc-ipts-erawatch-helpdesk@ec.europa.eu.

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EXECUTIVE SUMMARY

The macroeconomic performance of the Norwegian economy has remained strong in the current financial climate. In contrast, Norway's 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 €5.73b (NOK42.8b) in 2010, total R&D investment in Norway is 60 per cent higher than the EU-27 average in terms of per capita spending. R&D investment remains lower, however, in terms of proportion of GDP (1.7 per cent) 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 2010, the Industrial sector accounted for 43% of the total R&D expenditure at €2.48b (NOK 18.5b), the Higher Education sector accounted for 32% at €1.85b (NOK 13.8b), and the Institutional sector accounted for 25% at €1.4b (NOK 10.4b). Over 64700 Norwegians were involved in R&D work in 2011, accounting for 36,951 full time equivalents (FTEs). There were 7400 total full time equivalents per 1 million inhabitants in Norway in 2010, while there were only 5000 in the EU27.

The number of students in higher education has grown through the years, reaching 235,840 students in the 2011; of these, 60 per cent were women. The number of PhD graduates has increased by 132, or 10 per cent, and 1461 doctoral defences were achieved in 2012. The number of non-Norwegian PhD graduates is also increasing: 507 foreigners have disputed in 2012, which was 35 per cent of the total number of graduates that year.

In brief, the Norwegian economic system's relative strengths are in Human Resources and an Attractive Research System. The areas of relative weakness are found within Finance and Support and Private Sector Investments.

The goal of attaining the OECD and EU averages in R&D investment has dominated the Norwegian RDI policy discussions for over a decade. The explicit goal of reaching the 3 per cent target (i.e., R&D investment as proportion of GDP) has, however, lost its prominence during the last few years, although it still remains a long term goal. Norway remains a member of the group of "moderate innovators", with a below average performance; however, its recent performance in 2010-2011 has positioned it closer to the "innovation followers" category due to its strong performance in the area of Open, Excellent and Attractive Research Systems according to the Innovation Union Scoreboard (2013) (IUS). The IUS 2013 indicates that the relative weaknesses of Norway lie in Firm investments and Economic effects. Community Trademarks have grown, while Venture Capital Investments and community designs have strongly declined. The growth in human resources is above average in the EU27, while Finance and Support and Firm Investments are below average (IUS, 2013). The report also reveals the regional diversity in innovation performance and calls for the better tailoring of regional innovation support programmes to meet the needs of the individual regions. In total, the summary innovation index in Norway achieved a score of 0.485 in 2012 against a 0.544 average in the EU27.

Norway's R&D strategies are defined in periodic (every four years) white papers or in Messages to Parliament (Melding to Stortinget, hereafter Meld. St.).

The latest white paper on national innovation policy agencies is *Tools for Growth* (Meld. St. no. 22 (2011-2012). Published in April 2012, this paper sets the course for the development of two national innovation policy agencies - Innovation Norway and the Industrial Development

Corporation of Norway (SIVA). Together, these agencies and the Research Council of Norway administer a large number of the government's industry-oriented support measures, and this white paper aims to contribute to the development of a coherent and competent public support system for Norwegian companies. This study builds on the evaluations of Innovation Norway and SIVA, which were conducted in the wake of the 2009 white paper on innovation, *An Innovative and Sustainable Norway*, as well as commissioned reports and input from stakeholders. The primary recommendations include the formulation of new goals for both agencies that unite and clarify their respective tasks, a simplification of the portfolio of support measures administered by Innovation Norway, and the establishment of up to six new national seed capital funds.

In 2013, the new white paper on research was launched, Meld. St. no. 18 (2012-2013) "*Long-Term Perspectives -Knowledge Provides Opportunity*". The new white paper further extends the goals of the previous Meld. St. no.30 (2008-2009) "*Klima for forskning*" ("*Climate of Research*"). The paper provides clear suggestions for the further development of the research and education field in Norway. Among these suggestions, the paper focuses on the establishment of long-term planning for research as a result of the previous experience and difficulties with annual planning. The recruitment question is addressed, suggesting a cut in the proportion of temporary positions in institutions and proposing a test of the trial scheme for tenure-track positions. The further establishment of links and cooperation between research and industry and the entire public sector is suggested. Further possibilities and opportunities for international cooperation and coordination in the research field are also presented.

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.
Although there have been some positive developments in recent years, with BERD as percentage of GDP increasing from 0.82 in 2006 to 0.87 in 2010, 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 characterised by a high share of raw material-based activities that are knowledge intensive but not R&D intensive.

A major issue in the innovation policy debates in Norway is the country's strong dependence on resource-based export industries in general and the petroleum sector in particular. While the position of the Norwegian economy in resource-based sectors has proved to be a strong asset during the turbulent economic times worldwide, the Norwegian economy must diversify and develop strong positions in both the incumbent and the new knowledge-intensive sectors and niches. An extensive debate has taken place during the last few years that centres on the apparent paradox that while Norwegian scores are low on almost all standard innovation indicators, Norway's economy performs better than almost any other. 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 industry R&D to the overall economic product. The concern is that the indicators do not adequately capture the assets and specific sources of innovation in resource-based economies such as Norway's. Nevertheless, concerns persist that the Norwegian economy may not be sufficiently innovative to remain competitive over the longer term.

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1 INTRODUCTION

Norway has a small and open economy. It has a population of 5,051,275 inhabitants (01 January, 2013), which is approximately one per cent of the EU-27 population. Norway participates in the European Union's single market via the European Economic Area (EEA) agreement. The Purchasing Power Standard per Inhabitant achieved €46,900 in 2011 in Norway against €25,100 in the EU27 (Eurostat, 2013). Real GDP growth increased in Norway over the last three years, from a low of -1.6 in 2009 to 1.2 in 2011 (as compared to 1.5 for the EU-27).
In 2010, the total R&D expenditures were €5.73b (NOK42.8b)[1] or approximately 1.7% of Norwegian GDP. This amount was below the EU average of 2% in 2009. Norwegian industry accounted for 43% of the total R&D expenditures in 2010 (€2.48b or NOK18.5b). Norwegian BERD was lower than the EU average in 2011 (0.86% as opposed to 1.23% of GDP), although the shortfall is more than compensated 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 approximately €1.47b (NOK11b) for the 2008-2017 period (excluding operating costs). These investments derive from a national strategy for research infrastructure (*Tools for Growth*, 2008) and the resulting earmarking of funding from the Research and Innovation Fund.

Norway's primary 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 one of the OECD countries with the highest educational level across its population, and the number of employees with higher education qualifications in both the private and the public sector is steadily increasing.

Norwegian researchers have significantly increased their publication rates over the past decade. Since the mid-1990s, Norway has seen the largest increase in its impact, with a current level that is approximately 9% above the world average. The proportion of Norwegian scientific publications that are cited is higher than the EU average, according to the Innovation Union Competitiveness Report 2011. This development can be seen in the 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, 2013). Norway joined the European Patent Convention effective 2008. Norwegian Government is currently working on a policy white paper on Intellectual Property Rights (IPRs).

[1] Exchange rate NOK per 1 EUR: Annual average for 2012, NOK 7.47

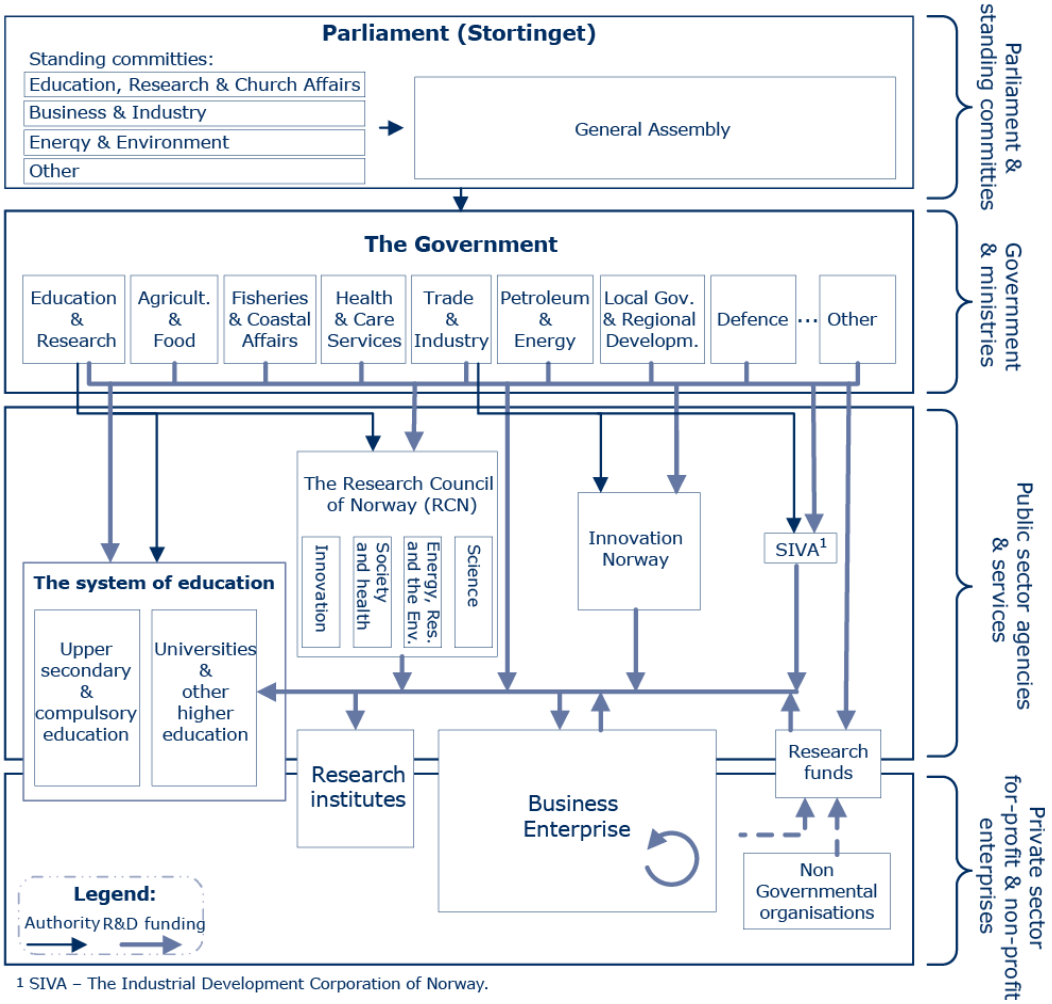

Figure 1: Overview of the Norwegian system of education, research and innovation, 2011
Source: NIFU (2011)

The national government plays an important role in the Norwegian research and innovation system. The government responsibility for research is organised according to the "sector principle": several ministries allocate sizable resources to research that is related to the 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 the national research policy and the 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 the primary institutional setting within the government for coordinating the overall R&D policy. The authority and influence of the Board within the strongly sector funding structure are, however, limited. The establishment in 1999 of the Research and Innovation Fund did, for 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 concerns voiced by the OECD (OECD, 2008). In addition to the Ministry of Research and Education, the ministries 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, considerably increased its appropriations for research and has now surpassed the Ministry of Trade and Industry as the second-largest research ministry.

The overall responsibility within the government for Norway's innovation policy resides with the Ministry of Trade and Industry. The general innovation policy is, however, less institutionalised and is of more recent origin than the R&D policies. 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, emphasising both improvements in the quality of services and business opportunities. The Ministry of Local Government and Regional Development has the 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; they were explicitly given this responsibility in a 2007 reform and offered tools to implement R&D&I strategies at the regional level. One key role of the counties is to administer the Regional Research Funds that were established in 2010 to promote regional innovation and regional development by fostering R&D within the priority areas of the seven respective regions.

Since its reorganisation in 2003, the Research Council of Norway (RCN) acts as the only operational research policy agency in Norway. In addition to funding research, the RCN has the mandate to advise the government about research policy and to create communication and coordination arenas for the actors in research, industry and government. The Ministry of Research and Education and the Ministry of Trade and Industry are the most important contributors to the RCN's budget, which was approximately €960m (NOK7.2b) in 2012.

Innovation Norway and The Industrial Development Corporation of Norway (SIVA) are the primary public institutions providing support for innovation, and as part of their portfolio, they are also involved in industrial R&D. Innovation Norway provides programmes and services with the objective of promoting innovation at the regional and national level, with a particular focus on small and medium sized companies. SIVA is involved in the provision of science parks, incubators and services to developing companies and venture capital to, primarily, start-up firms. A third institution is The Norwegian Design Council (NDC), which has the aim of increasing the understanding, knowledge and use of design in the innovation processes of Norwegian businesses.

In Norway there are in total eight universities, 22 university colleges (høgskoler) and nine specialised university colleges (vitenskapelige høgskoler og kunsthøgskoler). All universities are publicly owned. Most institutions of higher education are state-run and are responsible for the quality of their own instruction, research and dissemination of knowledge. About 12.5% of students in higher education attend private institutions.
Since the changes introduced in 2003 in the "*Law on the right to inventions made by employees*" (*Lov om retten til oppfinnelser som er gjort av arbeidstakere* , LOV 1970-04-17) ,universities and university colleges have been increasingly setting up technology transfer offices (TTOs) and using science parks and incubators to link up with industry.
The eight universities perform the largest part (about 80%) of research in the HEI sector. A large part of the funding for HEI research is the core funding channelled directly from the Ministry of Education and Research, but funds are also provided from project funding through the RCN. Expenditure on R&D in the higher education sector (HERD) was an estimated at €1.6m in 2008. The HERD intensity ratio (HERD as a % of GNP) is, therefore, 0.51% which is above the OECD and EU 27 averages of 0.39%.
There are relatively few R&D intensive companies in Norway. The largest R&D performers are in the oil and gas sector, with the state owned petroleum company Statoil. Only about one-half of R&D expenditure in the oil and gas sector is performed in-house. More generally, in Norway a comparatively larger part of R&D is performed outside the companies themselves, which

reflects the key role of research institutes within the business sector. Amongst EU top 1000 R&D companies there are 9 Norwegian companies (EU industrial R&D Scoreboard 2011):

No	Company	Rank	NACE Sector code	R8D investments 2010,€m
1	Statoil	81	Oil 8 gas producers (53)	262.27
2	DnB NOR	95	Banks (835)	214.43
3	Telenor	210	Mobile telecommunications (657)	89.13
4	Norsk Hydro	218	Industrial metals 8 mining (175)	87.59
5	Kongsberg Gruppen	226	Aerospace 8 defence (271)	80.28
6	Renewable Energy	311	Alternative energy (58)	47.97
7	Orkla	314	General industrials (272)	47.71
8	Visma	346	Software (9537)	42.38
9	Aker Solutions	349	Oil equipment, services distribution (57)	842.19

2 RECENT DEVELOPMENTS OF THE RESEARCH AND INNOVATION POLICY AND SYSTEM

2.1 National economic and political context

In the Norwegian research and innovation system, there is a strong emphasis on geosciences, biology and agricultural research. This emphasis is, in part, linked to the importance of natural resources such as oil and gas, fish and minerals in the Norwegian economy.
The development of petroleum-related industrial activities in the engineering and services sectors has had a particularly strong influence 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 the General University Fund's (GUF) objectives.

As has been mentioned, the Norwegian research system is based on a sector principle. Each department is responsible for the research in its sector.
The Ministry of Education coordinates the research policy through strategic processes and budget coordination and has agency management responsibility for the Research Council of Norway (RCN). Research messages are the primary strategy documents.

Three actors below the ministerial level are the main institutions for implementing the government's research and innovation policies. The Research Council of Norway is the executive research policy agency in Norway. This agency's 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 the RCN's budget, which was approximately €937m (NOK7b) in 2010. *Innovation Norway* and *SIVA* (the Industrial Development Cooperation of Norway) are the primary public institutions providing support for innovation. Innovation Norway is jointly owned by the Ministry of Trade and Industry (51 per cent) and the regional authorities (equally distributed between counties). Innovation Norway provides programs 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, primarily to start-up firms.

The Norwegian Research Council's strategy for the 2009-2012 period "*In Front of Research*" ("*I front for forskningen*") includes several key challenges:

- Capacity and quality challenge, both of which need to be improved to remain competitive in the increasingly globalised world.
- Community challenge, to orient research towards specific challenges in society and business.
- Structural challenge, to develop research system structure, cooperation and international participation.
- Learning challenge, to promote the research results that are useful for business and management and can inform governments and research institutions.
- Remain competent and transparent; the research results should be distributed and dialogue between science and society should be strengthened.

- Implement the Research Council's High North Strategy, which includes the cross-cutting initiative for the R&D in this region in all actual subjects and disciplines and organisational units in the RCN.

The performance of RDI in Norway is typically divided between the Industrial, the Higher education and the Institutional sectors.[2] In 2011, the Industrial sector accounted for 44% of the total annual R&D performance, the Higher Education sector 31%, and the Institutional sector 25% (NIFU, 2013). There are relatively few large R&D intensive companies in Norway. Including university hospitals, universities conduct the lion's share of research in the Norwegian Higher Education sector (approximately 85% in 2009). A further 9% of R&D is conducted by university colleges and 6% by specialised university colleges. The Institutional 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.

2.2 Funding trends

Current statistics on the funding trends in Norway are presented in the table below:

	2009	2010	2011	EU27
GDP growth rate	-1.6	0.5	1.2	- 0.3 (2012)
GERD (% of GDP)	1.8	1.7	1.7	2.03s (2011)
GERD (euro per capita)	999.9	1,099.6	1,204.8 (p)	510.5s (2011)
GBAORD - Total R&D appropriations (€ million)	2.259	2.604	2.772	91,277.1 (EU27 total 2011)
R&D funded by Business Enterprise Sector (% of GDP)	0.92	0.87	0.86	1.26 (2011)
R&D performed by HEIs (% of GERD)	32.0	32.3	:	24% (2011)
R&D performed by Government Sector (% of GERD)	16.2	16.4	:	12.7% (2011)
R&D performed by Business Enterprise Sector (% of GERD)	51.6	51.3	:	62.4% (2011)
Share of competitive vs institutional public funding for R&D	n/a	n/a	n/a	n/a

s - EUROSTAT estimate; p-provisional
Data Source: EUROSTAT, March 2013

After the financial crisis, the GDP in Norway has increased and achieved 1.2% growth rate in 2011 against a 1.05% European average. However, Norwegian R&D intensity is stable and lower than that of Europe, at 1.7% against 2.03% in 2011.

As previously mentioned, Norway performs below the EU average in terms of BERD as a per cent of GDP as well as in terms of R&D performed by the Business Enterprise sector. The

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

Barcelona target of 3 per cent was officially adopted by the Norwegian government in 2005; however, there is still no clear trend towards the achievement of this target.
Large-scale investments are currently being allocated to research infrastructure in Norway to address the estimated investment needs of approximately €1.47b (NOK11b) for the 2008-2017 period (excluding operating costs). These investments follow from a national strategy for research infrastructure ("*Verktøy for Vekst*", 2008).

The Global Competitiveness Report 2012-2013 ranked Norway in 15th place, against 20th in the previous ranking (144 countries included in the report), due to the notable improvement in Norway's innovative capacity, increased R&D spending by business, improved collaboration between business and academia and increased government procurement for advanced technological products. This report from the World Economic Forum indicates that Norway should be working on the further improvement of its research and development environment.

Government sector

The total intramural R&D expenditure amounted to €6.2b (NOK46.2b) in 2011. This is an increase of €125m (NOK 3.4b) compared to 2010 (NIFU, 2011). Approximately 80% of government funding for R&D in Higher Education Institutions (HEIs) are channelled directly from the Ministry of Education and Research, primarily as institutional funding. The majority of these funds are given as block funding; the remainder is distributed on the basis of reported student performance, research performance and strategic research considerations.

Business enterprise sector

Norwegian business enterprises conducted a total of €2.6b (NOK 19.7b) in research and development (R&D) in 2011. After a few stagnant years, this increase represents a nearly 7 per cent improvement from 2010 and an almost 3 per cent growth in fixed prices. A course has been established, however, to even better allow knowledge to be developed and exploited in the global competitive environment. The Norwegian government will include the following measures to encourage businesses to perform more industry research:

- access to highly qualified scientists,
- programs for funding and grants,
- improved conditions.

A total of 15,500 R&D man-years were completed in 2011, representing an increase of 1 per cent.

The capital area of Oslo and Akershus has been the dominant region in terms of R&D activity through the years. Over €2.56b (NOK19.1b), or 45% of total R&D spending, was invested within this region in 2010. Mid-Norway, with an R&D expenditure of close to €1.1b (NOK8.18b), accounted for 19% of R&D expenditures.

However, the northernmost counties of Troms and Finnmark, which account for approximately 5% of the national population, reported just 1.4% of total enterprise R&D.

Funding from abroad

Norway has taken part in the EU framework programmes (FPs) since 1987, and they are the most important international research programmes in which Norway is a participant. An

evaluation of Norway's participation in the FPs during the 2003-2008 period showed that the Norwegian rate of success in FP6 (2003-2006) was 25%, which was above the EU average of 18%. The success rate in the first part of FP7 (2007-2008) was approximately 22%, compared to an EU average of 16%.

In terms of funding, however, the Norwegian rate of success was less impressive, and the evaluation showed that Norway pays more for the FPs than is returned to the Norwegian participants (in pure financial terms) (Source: Godø et al, 2009).

Recent figures show that by March 2012, the Norwegian success rate in FP7 was approximately 23% and still well above the EU average. The share of projects with Norwegian participation is the highest in the Environment and the Security programmes (both under the specific programme cooperation). The research institutes account for the highest share of Norwegian participation in funded projects (43%), followed by companies (20%) and higher education institutions (30%) (Source: The Research Council of Norway).

Private nonprofit sector

Compared to other countries, there are few interest organisations in Norway that allocate funding at a level that could be seen as a significant part of total R&D funding. Generally, Norway has a weak tradition of donations for research from private organisations. The organisations that do exist, however, are contributing, in Norwegian terms, considerable amounts of money. Important allocations go to medical research, especially for cancer research through the Cancer Association (Kreftforeningen) and for heart research through the National Association (Nasjonalforeningen). In addition, funds for research come from private individuals. An important name in this regard is Trond Mohn, one of Norway's most important businessmen, who has given considerable funds to the University of Bergen, Haukeland University Hospital and the Nansen Centre.

2.3 New policy measures

The Norwegian Research Council has granted 19 research institutes in Norway with €3.48m (NOK 26m) in total through the STIM-EU stimulation scheme. Together with 22 Norwegian commercial companies, these institutes have been involved in 91 European projects. The scheme is an important step to make it more attractive for research institutes to join in research projects funded by the EU. The financing is one priority from the Research Council's draft budget for 2014. The budget proposed an increase of €9.10m (NOK 68m) in incentive schemes to strengthen Norwegian participation in the new EU Framework Programme, of which €6.43m (NOK 48m) is earmarked for STIM-EU growth.

SkatteFUNN is the first tax-deduction scheme for research in Norway and has been in existence since 2002. SkatteFUNN constitutes a major shift in the policy mix in the Norwegian system and represents a large share of the public support for R&D in Norwegian firms. The objective of the scheme is to increase private R&D expenditure and to enhance value creation in trade and industry. Under the SkatteFUNN scheme, all enterprises that are subject to taxation in Norway are eligible for a tax deduction for R&D expenses in approved projects. The eligibility of projects is contingent on approval by RCN based on whether the project falls within the definitions of an R&D activity. It is notable that the firms that are not in a position to pay tax because they have no profits are nevertheless eligible for a cash refund. In 2011, the budgeted tax-deduction was

€256.76m (NOK 1.918m). The two most heavily populated counties in Norway, Oslo and Akershus, have applied for more than 30% of the sum over the program's lifetime.

The Norwegian Research Council's Industrial PhD programme builds long-term expertise in companies through increased research efforts. Companies can apply for support for the three (or four years) for an employee who wants to obtain a PhD. The support is limited to 50 per cent of the grant rate. For 2012, this sum was € 58,545 or (438,500 NOK). The funds are not provided as a personal scholarship for the candidate but as project support to the company. There is a number of criteria that must be met; among them is a binding agreement with a degree rewarding institution. It is believed that the programme will increase the long-term development of competence in business and scientist recruitment and will achieve a higher appreciation of the interaction between business and academia.

2.4 Recent policy documents

The white paper entitled "*Verktøy for vekst*" [*Tools for Growth*] (Meld. St. no. 22 (2011-2012)) was published by the Ministry of Trade and Industry in April 2012. The white paper sets the direction for the future development of two national innovation policy agencies - Innovation Norway and the Industrial Development Corporation of Norway (SIVA). Together, these agencies administer a large number of the government's industry-oriented support measures, and the white paper aims to contribute to the development of a coherent and competent public support system for Norwegian companies.

The white paper builds on the evaluations from Innovation Norway and SIVA that were conducted in the wake of the 2009 white paper on innovation (Meld. St. no. 7 (2008-2009) *An Innovative and Sustainable Norway*), commissioned reports, and input from stakeholders. The primary recommendations include the formulation of new goals for both agencies that unite and clarify their respective tasks; a simplification of the portfolio of support measures administered by Innovation Norway; and the establishment of up to six new national seed capital funds.

In 2013, the new white paper on research was launched, Meld. St. no. 18 (2012-2013) "*Long-Term Perspectives -Knowledge Provides Opportunity*". The Norwegian government's assessment is that the research performed in Norway is of good quality and that the system works properly, though there is potential for improvement. In the new white paper on research, the following areas of improvement are suggested:

- further improve quality and create more research and education in the international top class research;
- better prepare for innovation in the research system and promote the development of industry and the public sector;
- strengthen internationalisation and build a good relationship between national and international instruments;
- improve cooperation in the development and use of knowledge.

The new paper further develops the previous report Meld. St. no.30 (2008-2009) "*Climate of Research*". Research policy remains oriented towards five strategic goals, where the research will contribute to meeting global challenges, particularly environmental and climate change; good health and less social inequality in health and health care services; research-based social policy and professional practice in welfare services; a knowledge-based economy in the country; and economic development in the areas of food, marine industries, tourism, energy, environment, biotechnology, ICT and new materials/nanotechnology.

The long-term goal to have the overall research effort constitute three per cent of GDP remains

unchanged. The government's ambition for public research funding is that it should constitute approximately one per cent of GDP, i.e., approximately one third of the target for total research and development efforts.

The government will continue to increase research funding in the years ahead. The government recognises that predictability, transparency, time and stability are required to build up strong research programmes so that Norway can compete internationally in priority areas. The government will prepare a long-term plan for research and higher education that will take a ten-year perspective and will be reviewed every four years. The plan is a tool to target efforts in the areas where Norway has a strategic advantage or to meet future needs for knowledge in key areas and to identify the need for investment to build knowledge in connection with Norway's priorities. The Ministry will establish a system in which all key stakeholders have the opportunity to record their priorities. The first long-term plan to be submitted is the Ministry of Education's budget proposal for 2015.

People are a core element in research and education. To contribute to knowledge development and sharing, the Norwegian government will therefore facilitate the mobility of staff between institutions, sectors and countries. Institutions are encouraged to develop a transparent personnel policy and reduce the proportion of temporary staff. To enhance the recruitment of particularly talented researchers in mathematics and natural sciences, technology, medicine and dentistry, the government will establish a trial tenure track with a quota of up to 300 employees.

In addition, the government will emphasise the importance of the quality of education and expertise for social change and innovation. This emphasis should be integrated more clearly in the government's research policy.

To achieve these goals, Norway will continue to improve its functioning research system, with high quality research, a high degree of internationalisation of the research and the effective use of research resources and the development of results.

2.5 Research and innovation system changes

The Ministry of Local Government and Regional Development has the 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; in 2007, the counties were explicitly given this responsibility and offered tools to implement R&D&I strategies at the regional level. One key role for the counties is to administer the Regional Research Funds that were established in 2010 to promote regional innovation and regional development by fostering R&D within the priority areas of the seven respective regions.

Norway is currently involved in the FP7 European programme that will be completed in 2013, and the Norwegian Ministry of Education and Research has already presented 4 inputs to the EU on the FP8 or Horizon 2020, which will start in 2014. Therefore, Norway is an active contributor to the development of the new Framework Programme for research and innovation. While supporting the main proposals of the European Commission, Norway has suggested some changes and additions. They include, among others, the broader focus on maritime and marine research to ensure sustainable management of the marine ecosystem, emphasize the role of Arctic research and the role it can play in the climate change research. Simplification of administrative procedures and rules for participants is named as desirable for the attraction of small and medium enterprises to participate in the program, stronger incentives for gender balance in Horizon 2020. Furthermore, Norway is seeking a stronger integration of the knowledge triangle in the Programme – more interaction between research, education and innovation.

There is a trend toward the greater coordination of national programs, not least through Joint Programming Initiatives (JPI), where countries put a greater proportion of their national research budgets into a common pot.

2.6 Regional and/or National Research and Innovation Strategies on Smart Specialisation (RIS3)

Because Norway does not receive structural funds, the central state authorities in Norway currently have no ambitions to relate to S3 or to develop a national S3 strategy. However, one county, Nordland, is the first and to date only Norwegian region that is registered at the S3 platform at JRC-IPTS in Seville. The Nordland County Council, in partnership with regional policy and R&D institutions, has started working on an S3 strategy based on partnership and the lessons learned from the Programme for Regional R&D and Innovation (VRI) funded by the Research Council of Norway. An informal network of partnerships has been established in Nordland and other Norwegian and Nordic regions that are working with S3 strategies. There has not yet been any decisions made on which sectors will be given priority in the Nordland S3 strategy. This work will be coordinated with the preparation for the next iteration of the VRI Nordland program.

2.7 Evaluations, consultations

The year 2012 was truly a year of evaluations. One of the important reports, conducted on behalf of the Ministry of Education, was the evaluation of the Research Council in Norway (RCN), presented in September 2012.

The report concludes that the RCN has developed positively over the last 10 years. The report shows that the Research Council achieves good results in the Norwegian research and innovation system and helps to improve the quality of Norwegian research. The RCN has developed important changes to the system, particularly the establishment of centres of excellence and large applications, and it has shown significant improvements in the quality and efficiency of its proceedings. In addition, the evaluation shows that the Council has gained legitimacy in research institutions and with consumers in general and has affected the institutions' priorities.

The Norwegian model, with one Research Council for all research, is unique in the world. The aim behind the RCN's creation in 1993 was to facilitate a more coordinated research and innovation policy.

- Though the main conclusion is positive, the evaluation does suggest that the RCN must balance the public sector's needs and Norway's strategic needs.
  The evaluation also identifies some room for improvement:
- The RCN must continue to strengthen the quality of research.
- The RCN should establish mechanisms for risk-averse basic and applied research. There is a need for instruments that create innovation and change.
- The RCN should systematically use evaluations and bold future studies inter alia as a part of their cycle in various research programs.
- There is a need for clearer strategic choices in the internationalisation of Norwegian research.

> The results of this evaluation will be used in the work to formulate the research policy for the coming years in a new research report (to be presented in the spring of 2013).

The Norwegian PhD education system was also evaluated in 2012. The main conclusion of this evaluation states that Norway has a high quality PhD education system. This system is also well-funded, well-organised, offers very good working and learning conditions for PhD candidates, and offers good career prospects afterwards. Some issues, however, have not yet been addressed. For example, there is no systematic evaluation of the postgraduate careers of doctoral holders. The evaluation also notes that the demands for a reduction in the time-to-degree and the increased focus on generic training could possibly negatively affect the research results and training. (Source NIFU, rep. 25/2012)

Several programs have been evaluated recently in Norway; among them are the VRI, NCE, and ARENA.

The Research Council of Norway is in the process of developing a regional strategy to improve its role in the regional partnerships and to increase awareness of the regional dimension in program design. The Research Council's program for R&D and innovation in the regions is an important contribution to the government's plans to transfer more responsibility for R&D and innovation activities to the regions. In 2007, the VRI program was introduced (Program for Regional R&D and Innovation) with the aim of fostering innovation, knowledge development and added value through regional cooperation and a strengthened research and development effort within and for the regions. The VRI was evaluated in 2012 by Oxford Research. The overall results show that the VRI provides a substantial contribution to the development of regional research and innovation systems and thereby improves the prospects for innovation in companies.

The Norwegian Centres of Expertise (NCE) programme was launched in 2006 and is aimed at strengthening the innovation and internationalisation processes in clusters based on collaboration among companies, research and educational institutions and the public sector. The NCE programme was evaluated in 2011; the evaluation stated that the cluster firms have performed well and that the trend of value added is positive for all but two (NCE Oslo Cancer Cluster and Tourism). The overall results are positive for both the clusters and for society. It is estimated that there is an unrealised growth potential of €13.39b (NOK100b) in the NCE and Arena clusters.

The Arena programme was organised in 2002 to increase production and profitability in the regional cluster and industrial systems. A regional cluster is defined as a concentrated presence of firms within the same value chain or industry within the same locality or geographical region that together have the potential to form a well-functioning industrial competence system. The actors participating in an Arena project must have a strong potential to enhance and improve the network in a way that increases the firms' abilities for further innovation and improved profitability. The responsibility for the Arena programme is shared jointly between SIVA, Innovation Norway and the RCN. The funding is provided by grants from the Ministry of Regional Affairs and the Ministry of Trade and Industry. The annual budget is approximately €5.35m (NOK40m). Any grant from the programme requires joint funding from the participants and the regional authorities. The Arena programme was evaluated in 2011, and it was found that the program has achieved the main objective of strengthening the regional business environment capacity for innovation and value creation through increased interaction between industry, research institutions and the public.

3 STRUCTURAL CHALLENGES FACING THE NATIONAL SYSTEM

In strong contrast to the excellent macroeconomic performance of the Norwegian economy stands its 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 the Innovation Union Scoreboard) group of "moderate innovators" with a level of innovation performance and average annual growth in innovation that is below the EU-27 average. Norway's position as moderate innovator remains unchanged in the Innovation Union Scoreboard (IUS) 2011.

The Norwegian system's relative strengths are present in the following fields: Human resources; Open, excellent and attractive research systems; Finance and Support and Linkages and Entrepreneurship. The relative weaknesses are in Intellectual assets and Economic effects. However, even if there is an annual average growth, some indicators still lie below the EU27 average.

Despite changes in the scores for some of the 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 that are far stronger 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 the past declines for 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 among the Nordic countries and is substantially lower than 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. The students' interest in 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 theissue. Several measures target the position of scientific and technological subjects in secondary education as part 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 for 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).

The low level of unemployed human resources in science and technology as a percentage of total unemployment is noteworthy. 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, the

debates highlight that the shortage of S&T engineers is a problem for the Norwegian economy and that this problem will only become more acute in the future.

Increasing the number of PhD fellows

The number of PhD candidates has almost doubled over the last eight years, though Norway is still behind some neighbouring countries such as Sweden and Finland. In the recent evaluation of the PhD education system in Norway, it has been noted that the growth in PhD candidate numbers has been accommodated without a substantial growth in academic positions.

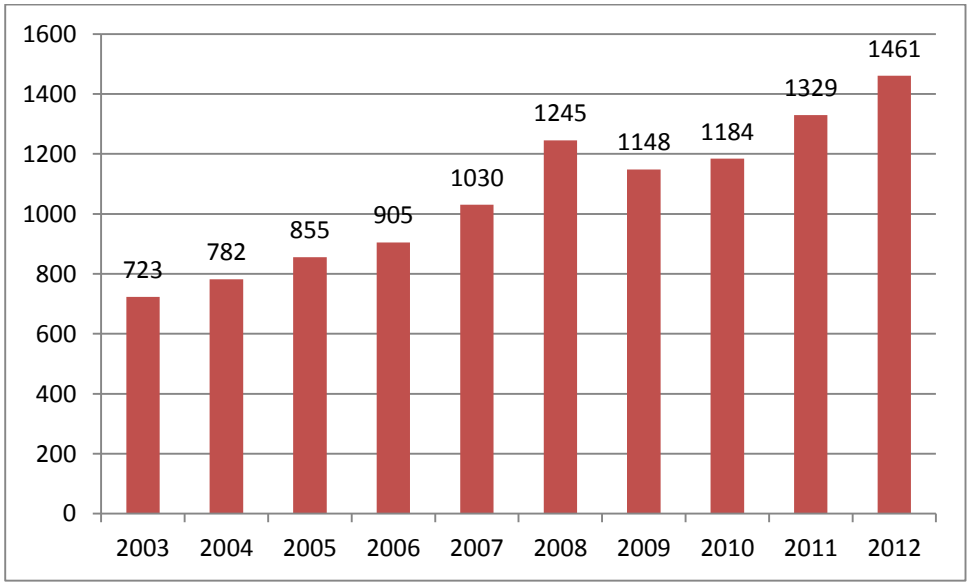

Figure: Number of annual PhD graduates in Norway (based on the data from www.nifu.no; 2013)

The number of international publications per 100,000 population achieved 212 in 2011. This number is lower than Sweden's 221 and Denmark's 239; however, it is much higher than the EU27 average. It can be concluded that Norway performs higher than the EU average though lower than the neighbouring countries. In terms of international scientific co-publications, Norway performs almost 5 times better than the EU27 average (Innovation Union Scoreboard, 2013).

To increase training and skills in industry, Ph.Ds. are awarded by the RCN under the user-driven innovation programmes. The Industrial Ph.D. scheme provides companies with the opportunity to enhance their research expertise without having to participate in a more comprehensive project (a User-Driven Innovation Project or a Knowledge-Building Project with User Involvement). Approximately €8.03m (NOK60m) was set aside for the Industrial Ph.D. scheme in 2010, and funding was awarded to approximately 40 new Ph.D. candidates. In 2011 and 2012, the annual budget was approximately € 5.15m (NOK 38.5m). As in 2010, the number of new candidates was approximately 40 in 2011, and it is expected to be the same in 2012.

Knowledge-intensive services, licenses and patents

Norway is currently performing lower in terms of patents applications and medium- and high-tech product exports as a % of total product exports than the EU27 average. The same situation can be seen with the licence and patent revenues from abroad, which are 33% lower than the EU27 average. The knowledge-intensive services exports as a % of total service exports are, however, slightly higher than the EU27 average. Norway is listed as a number 14 (out of 144) in terms of its protection of IPR in a new report from the World Economic Forum (The Global

Competitiveness Report 2012-2013). In 2009, 101 patent applications per million population in Norway were registered, while in Sweden, Denmark and Finland, these numbers were 332, 243 and 216, respectively. The Norwegian government is currently working on a new white paper that is focused on IPR.

Increasing industrial R&D

The R&D intensity of the Norwegian business sector is relatively low, and for years, increasing industrial R&D has been seen as a key challenge. 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 slightly 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 – 0.86 in 2011. The BERD/GDP ratio is far below the EU average, which was 1.23% in 2011 (Eurostat, 2012).

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 noted 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. In regard 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 along with other resource-based and export-oriented sectors have high productivity and are highly *knowledge*-intensive because 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 appears to have contributed to a drop in 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 the resource-based sectors has proved to be an asset during turbulent economic times worldwide. However, it is expected that the Norwegian economy will need to diversify and develop strong positions in both the incumbent and the new knowledge-intensive sectors and niches. An extensive debate has taken place during the last few years regarding the apparent paradox seen in the Norwegian economy, where it performs, on the one hand, better than almost all other national economies in the world, while on the other hand, the Norwegian scores are low on almost all standard innovation indicators. It is generally assumed that part of the explanation for this paradox is that the standard innovation indicators do not adequately capture the assets and the specific sources of innovativeness in resource-based economies such as Norway's.

The need to foster growth in knowledge and in the R&D-intensive sectors of the economy has been identified as a key challenge for the Norwegian research and innovation system (TrendChart Mini Country Report Norway, 2011). The OECD, in a comprehensive review of the Norwegian innovation policy published in 2008, has strongly emphasised the need to

restructure the Norwegian economy towards other knowledge-based activities 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 primary motor for the Norwegian economy and one of the main explanations for why the Norwegian economy has fared better than most other Western economies during the present financial and economic crisis. New oil and gas reserve discoveries, new technologies for the more effective exploitation of existing reserves, the development of CCS technologies and the lack of agreement on caps for 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 in the Norwegian economy (fishing, mining) are highly knowledge-intensive, providing a basis for continued productivity improvements within these sectors as well as for diversification into related and new knowledge- and R&D-intensive economic sectors.

The diversification of the Norwegian economy from the foundation of its unique strengths is, inter alia, dependent on 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 during the commercialisation phase, and often do not succeed in growing into medium-large companies. Concern over their access to venture capital is often raised in this context (TrendChart, 2009).

The commercialisation of academic results has been addressed through the FORNY program (1995-2010) and its successor FORNY2020. The Research Council of Norway has been continuously working on the development of support mechanisms and funding schemes to help the technology transfer offices (TTOs) to select the best projects and to attract capital to produce new or improved products, services and processes and strengthen the collaboration between R&D institutions and industry (The Research Council of Norway, 2012).

HUMAN RESOURCES	
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	1.9
Percentage population aged 25-64 having completed tertiary education	48.8
Open, excellent and attractive research systems	
International scientific co-publications per million population	1483
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	12.17
Finance and support	
R&D expenditure in the public sector as % of GDP	0.84
FIRM ACTIVITIES	
R&D expenditure in the business sector as % of GDP	0.86
Linkages & entrepreneurship	
Public-private co-publications per million population	115.9
Intellectual assets	
PCT patents applications per billion GDP (in PPS€)	3.61
PCT patents applications in societal challenges per billion GDP (in PPS€) (climate change	0.80

HUMAN RESOURCES	
mitigation; health)	
OUTPUTS	
Economic effects	
Medium and high-tech product exports as % total product exports	16.70*
Knowledge-intensive services exports as % total service exports	49.4
License and patent revenues from abroad as % of GDP	0.17

*2010
Unless specified, figures are for 2011
Data Source: Innovation Union Scoreboard 2013

4 ASSESSMENT OF THE NATIONAL INNOVATION STRATEGY

4.1 National research and innovation priorities

Norway's multiannual R&D strategies are defined in periodic (every four years) white papers to the *Storting* (Norwegian Parliament). The latest white paper on the national innovation policy agencies is *Tools for Growth (Verktøy for vekst)* (no. 22 (2011-2012)), presented earlier in this Erawatch report. The latest paper on research, Meld. St. no. 18 (2012-2013) "*Long-Term Perspectives -Knowledge Provides Opportunity*" was also presented earlier in this report.

The overall objective of Norwegian **innovation policy** is to support long-term sustainability and to protect people's welfare. This policy objective emerges in the first white paper in Norway explicitly addressing innovation policy.

Over the recent years, R&D and innovation strategies have been developed for specific areas that represent strengths in the Norwegian economy. These areas 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 within which a key role is played by a ministry-appointed board covering key actors within industry, education and research as well as in the policy system. The board serves as an advisor to the Ministry and is responsible for bringing together the relevant actors in a unified approach to promote competence building, R&D, and innovation based on a national technological strategy for the entire 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 that has seen the recent issue of a national strategy is marine bioprospecting. The strategy was published in 2009 and was 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 bioprospecting is viewed as an important field that may contribute to new and sustainable wealth creation in Norway, and the strategy maintains that funding for research and support for commercialisation relating to marine bioprospecting will be increased.

The government is presently reviewing its IPR policy and preparing a new white paper on IPR. The recent rapid development in the area of intellectual property needs to be reflected in this document. Report no. 7 (2008-2009): *An Innovative and Sustainable Norway* pointed out the need for greater expertise on intellectual property rights to confront increasing global competition.
In the state budget for 2013, the government will allocate €1.14m (NOK8.5m) to initiatives on intellectual property rights, of which €0.6m (NOK4.5m) is designated for the establishment of an

appeals committee for IPR. A separate appeals body will make the processing of complaints simpler and less formal than bringing it before the courts.
In regard to the overall policy mix, Norway generally appears to have a balanced and efficient set of R&D and innovation policies. The 2008 OECD report on the Norwegian innovation system maintained that the country had a broad and fairly complete set of instruments to support research and innovation. The main criticism in this report regarded Norway's 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 notes that Norway 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 of the environment, energy and health (ERAWATCH country report, 2009).

Norway has several policy measures that are aimed at stimulating business sector R&D. These measures 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, it has been argued in recent years that there is insufficient support for industrial R&D. This criticism was, for example, a key part of the 2011 national budget (ERAWATCH report, 2010).

The primary developments in recent years include an increased emphasis on support for the climate and energy research and for regional innovation. The 2010 national budget saw a marked growth in public R&D funding, and to a significant extent this growth was 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 to promote innovation at the regional level (NIFU STEP, 2009).

Norway admits to having structural challenges and new policies are directed towards this. Increasing the number of S&T graduates is embedded in the overriding priorities in the 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 previously mentioned, 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 recommendation has been followed up in the form of a new strategy that is entitled *Science for the Future* and that runs from 2010 to 2014. A primary 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 achieving 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.

4.2 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, which 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, in recent years, the focus has increasingly been directed towards research results and how research benefits society. This focus is reflected in the emphasis in the current research policies on addressing global and societal challenges in areas such as the environment, climate, energy, and health.

The last few years of Norwegian research and innovation policy was characterised by few new initiatives, low growth and marginal changes in priorities. The exception to this general picture was the so-called "climate agreement" in 2008 between virtually all political parties. Part of the agreement was a decision to increase appropriations for 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 the Centres for Environmentally 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 the 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 in regard 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 of promoting long-term knowledge development that can contribute to innovation and value-creation or to solving societal challenges. To demonstrate the size of these large sectoral programmes, the Aquaculture programme (HAVBRUK) amounted to approximately €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-Policy TrendChart Innovation Policy Progress Report Norway, 2009).

SkatteFUNN offers tax deductions for industrial R&D, and the scheme has gained increased 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 SkatteFUNN is primarily used by SMEs, the BIA scheme is to a large extent designed for and primarily 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. The recent evaluations 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 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 policy 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 Environmentally 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 are consistent with general international trends.

The TrendChart Mini Country Report for 2011 provides an overview of the policy measures that have been introduced since mid-2009. The most important new measure is the Regional Research Funds, which aim 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 since 2010. These funds are administered by the regional authorities in cooperation with the Research Council of Norway, and each fund incorporates the strategic priorities of the counties belonging to the region that 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 significant controversy in both cases. In the national budget for 2012, which was presented to Parliament in the autumn of 2011, the government proposed closing down the Fund for Research and Innovation (see 3.2). The 2012 budget also saw the disbandment of the so-called gift enhancement scheme through which the state tops private financial donations for basic research with an amount equal to 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 each assigned a key role in the promotion of welfare and value creation and hold centre-stage in regard 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, the lack of efficient coordination has been identified as a weakness. The strongly sector oriented funding system limits the scope for coordinating allocations to research and innovation. This observation was included 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.

4.3 Assesment of the policy mix

The comprehensive evaluation by the OECD in 2008 is a point of departure for assessing the Norwegian policy mix; this evaluation concluded that Norway has a well-balanced and efficient set of R&D and innovation policies. The evaluations offered generally positive conclusions regarding the 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; the evaluations indicate that these instruments are generally effective and well managed. As a

consequence of the highly sectored 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 the 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. Because 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 because the policy mix has developed as layers of new instruments are added on top of the extant instruments, which are rarely disbanded altogether.

The Research Council of Norway significantly reorganised during 2011 into 4 divisions. As a result, the division for innovation has targeted closer linkages between research and industry. This division also evaluated the effectiveness of some of its large programmes. 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 issued a follow-up in the form of a white paper, which, inter alia, proposes simplifying the goal structure of Innovation Norway while leaving in place the many instruments (targeting agriculture) that have been widely criticised as having 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 during the second half of the 2000s.

A prerequisite for innovation, value creation and growth is the 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 level 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 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 SMEs, the scheme has not had, and could not in itself have, significant effect on overall BERD, which is for the most part by far performed by large companies. The instruments targeting these companies, e.g., the BIA Scheme, have remained stable although they have been 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 result indicates that the objective of increasing 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 which developments in the industrial structure will prove to be viable
over the longer term.

A possible new approach to sustain long-term competitiveness and stimulate diversification may be to consider policy measures that 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 in addition to, or even at the expense of, the measures that focus on reinforcing the 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 appears from this perspective to be 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 than R&D conducted by new industrial firms that deviate from the system and thus are more dependent on built-up internal capacity.
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 of its future scenarios. 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, investment 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 emphasise 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, the environment and sustainable energy should be increased. Policy strategies have been followed up by increased funding for these priority areas and new instruments, notably the centres for environmentally 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 whether the policy action and these measures will prove appropriate for tackling the challenge of restructuring the economy.

Challenges	Policy measures/actions addressing the challenge[3]	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.
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.

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

Challenges	Policy measures/actions addressing the challenge[3]	Assessment in terms of appropriateness, efficiency and effectiveness
Focus on the High North	Develop business and knowledge in the region in a 10-15 year perspective; further cooperation with Russia;	Petroleum industry is growing in the Arctic region. To strengthen the Norwegian position in the development of the Arctic, establish international cooperation and sustainable development the Norwegian government is seeking and implementing the new measures for the participation in the R&D of the Arctic region.

Data Source: Partly taken from Erawatch Country Report 2011

In light of the consensus in Norway regarding its policy challenges, several areas of the Norwegian system are currently being evaluated. The system's policy mix is currently under assessment, in large part in preparation for the next white paper on research, which the Ministry of Research and Education will present in the spring of 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 the consistently unfavourable international comparisons of Norwegian IPR use and of the relatively recent transition to the European Patent Convention, the Ministry began work on a white paper on the IPR system and its use in Norway. Another more indirect area that is currently being assessed is the educational system, where an on-going evaluation of a recent reform in the school curricula (Kunnskapsløftet) is due in 2012.

5 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. This alignment of priorities is also true for the latest European Commission objectives (July 2012).

To ensure the effectiveness of the research systems, continuous evaluations of the entire Norwegian Research system are performed. These evaluations include an evaluation of the Research Council in Norway as well as of particular programs and priority areas (VRI, FORFI etc.). The results are analysed and the conclusions are further implemented.

Norway has not implemented the EU recommendations on a scientific visa. However, in January 2010, a new Immigration Act came into force in Norway that simplifies the registration procedures for EU/EEA/EFTA nationals and makes it easier for skilled workers from countries outside of the EU/EEA/EFTA to apply for employment in Norway. At the same time, Norwegian researchers are encouraged to search for funding for foreign stays in the institutions as a part of their research work, for example through FRIPRO of the Research Council of Norway. These changes should contribute to a more open labour market for researchers.

Increased cross-border cooperation in research is a key objective of 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 the extent to which research policy manages to effectively balance between domestic and international initiatives, remains questionable in Norway as it is in most other European economies (see Ebersberger, Herstad, Iversen, Som & Kirner, 2011). In the current situation, the 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 formalised Nordic cooperation framework under the auspices of the Nordic Council of Ministers. In this context, a noteworthy activity is the joint programming initiative, 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 of funding research in fields related to energy, the environment and climate.

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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 Industrial Development Corporation of Norway
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

This analytical country report is one of a series of annual ERAWATCH reports produced for EU Member States and Countries Associated to the Seventh Framework Programme for Research of the European Union (FP7). 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.

The Country Report 2012 builds on and updates the 2011 edition. The report identifies the structural challenges of the national research and innovation system and assesses the match between the national priorities and the structural challenges, highlighting the latest developments, their dynamics and impact in the overall national context. They further analyse and assess the ability of the policy mix in place to consistently and efficiently tackle these challenges. These reports were originally produced in December 2012, focusing on policy developments over the previous twelve months.

The reports were produced by independent experts under direct contract with 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 external experts.

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As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

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Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

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